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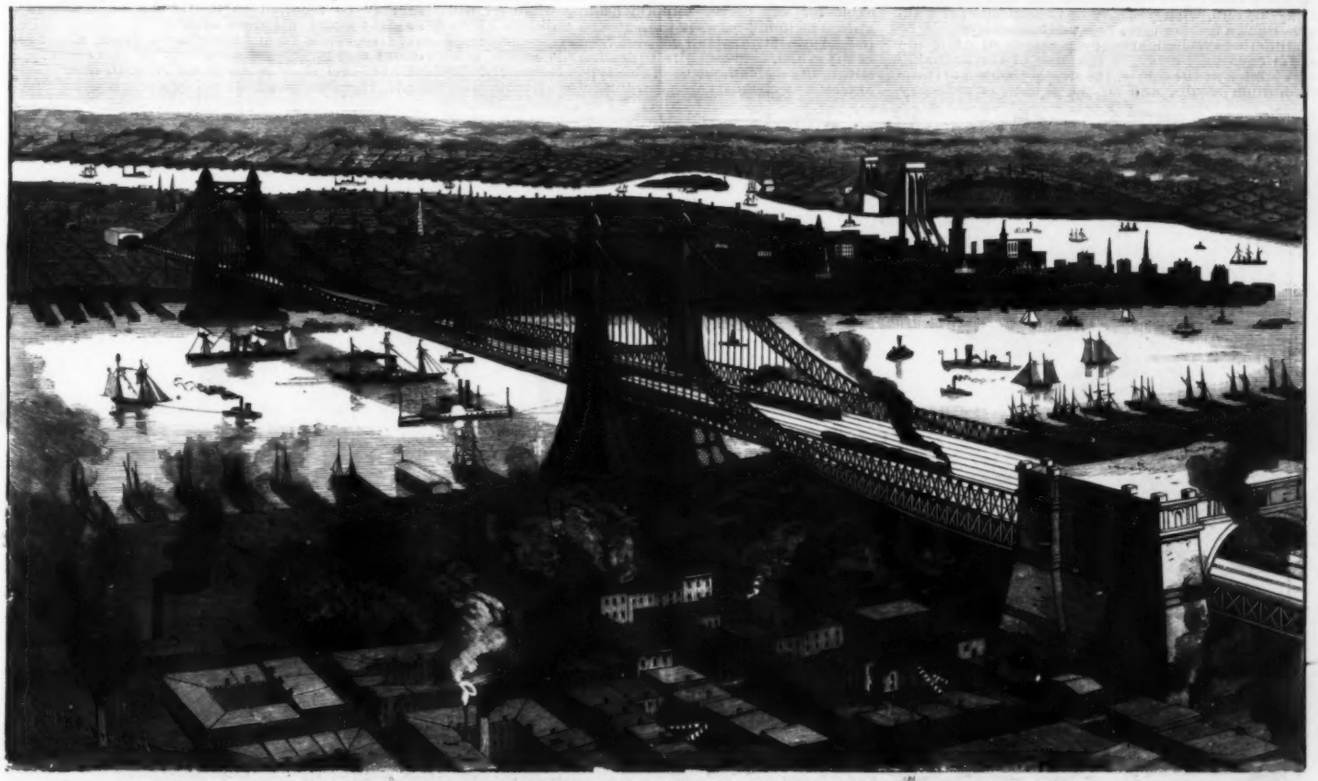


FIG. 1.—SUSPENSION BRIDGE WITH STIFFENED CABLES—PROPOSED HUDSON RIVER SUSPENSION BRIDGE. Span, 3,100 feet.

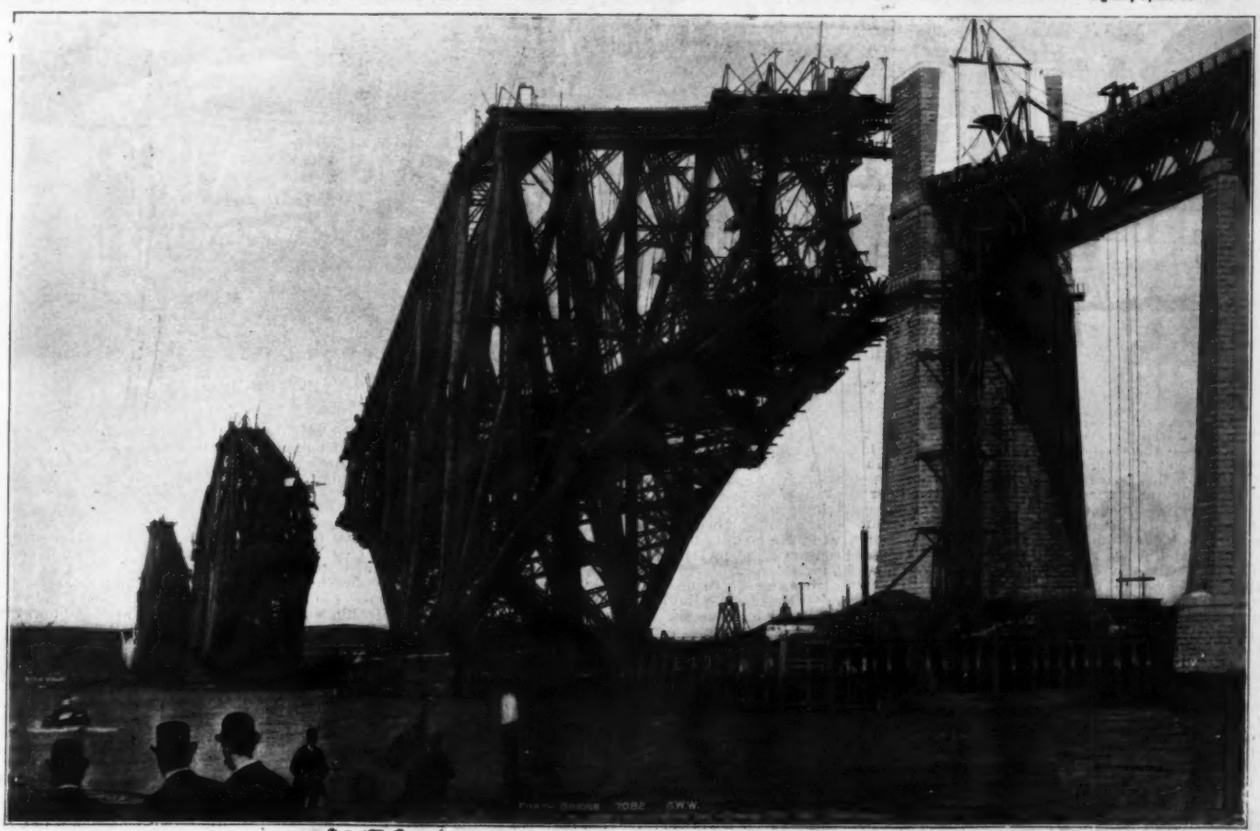


FIG. 2.—RIVETED CANTILEVER TYPE—FORTH BRIDGE. Spans, 1,710 feet.

[Continued from SUPPLEMENT, No. 1252, page 20073.]

LONG-SPAN BRIDGES.*

By Prof. W. H. BURR, of Columbia University.

THE skeleton structure shown in Fig. 4 was a provisional design, only made for the purpose of comparative estimates between a cantilever and a stiffened suspension bridge, each of 3,100 feet span. That was the question before the board of engineers which, some five years ago this summer, considered the feasibility of spanning the Hudson River at New York city with a single span of a little over 3,000 feet in the clear.

I have said that it was necessary to use elastic equations of equilibrium in connection with the design of the stiffening trusses for this type of stiffened suspension bridge. That is true if the truss is continuous from one end of the span to the other, as I think it advantageously may be; but if the stiffening truss is jointed at the center, there is introduced the additional condition that the bending-moment at that point shall always be zero, whatever may be the condition of loading. Such a feature gives one additional equation of condition which eliminates the necessity of using the elastic equation; hence, in the case of the stiffening truss jointed at the center, the simple problem of static equilibrium results, and all the equations necessary for the computations are equations of statics without any reference to the elastic qualities of the material. A center-hinged stiffening truss was used, as shown in the figure, by the board of engineers for the comparative estimates adverted to. There is little difference in economy between a continuous stiffening truss and one jointed at the center. There are somewhat greater bending-moments in the latter case; but, on the other hand, they are bending-moments whose maximum prevails only at a point in each half-truss, making the average moment comparatively low; whereas, in the continuous stiffening truss, maximum bending-moments prevail over approximately one-third of the span. There is, however, one criticism that may be made as in all cases of pin-joints or hinges in the central portions of the structure; those joints decrease stiffness, although that is a matter of less relative consequence in long spans than in short ones.

The other principal methods of stiffening suspension bridge cables are shown in Figs. 1, 3 and 5, accompanying. We have in one a type of structure which has been used for the Tower Bridge across the Thames at London. The central span is a bascule structure of 200 feet clear span. One-half of the stiffened span reaches to the top of the tower adjacent to the bascule span; but the other half reaches only to the top of a lower tower at the shore end of the span. Both the curves are parabolic, but they are not branches of the same parabola. The lower curve is one parabola nearly up to the span center, but another parabola completes the curve over the remainder of the span. The other curve crossing the first at the center is formed in precisely the same way, but with the portions of the span reversed. The center line is also a parabola of two equal branches—that is, it is a parabola of the same parameter for the entire span.

The object in placing two cables in that manner, with bracing between them, is to accommodate unsymmetric or partial loading. The most unbalanced loading is that which covers the whole of one half-span. In the figure one of the curves (upper in one half-span and lower in the other) represents the true position of a cable for such loading. The broken line curve, midway between the others, shows the parabola for a uniform load over the entire span. The true parabolic cable for any partial uniform loading whatever will always be found between the extreme positions above indicated. The bracing between the extreme positions of the cables, together with the cables themselves, constitute the stiffening truss of this type of structure. If two tension members are placed in those extreme positions, so that the line of resistance for any portion of uniform loading whatever will lie between them, the only function which the bracing connecting the cables will have to perform is to transfer such small amounts of shear as may be required to make the proper distribution of tensile stress between the cables. Whenever a uniform load covers the entire span, the bracing will have no duty to perform except simply to keep the tension members separated at their proper distances. That is a form of stiffened suspension bridge (a stiffened arch when it is turned over) which has been strongly advocated by the English engineer, Max Am Ende. It has many advantages. In fact, I am not sure that it may not be the most economic system of stiffening for the longest spans. The roadway or the railroad platform would be stiffly suspended from the stiffening truss; but simply deep enough and stiff enough in itself to take the shocks, irregular applications, impacts, or vibrations of any rapidly moving load. It would have no function as a stiffening truss. The entire stiffening-truss function, so to speak, would be performed by the two tension members and the bracing between. It is obvious, I think, that under these circumstances this bracing may be relatively very light, and that the two tension members are in position to carry the stresses very directly from the point of application of the load (wherever that may be) to the tops of the towers and the anchorage. It is not only a very economic type of stiffened suspension bridge, but, when you turn it over and make a stiffened arch, it is a very economic form of such a structure.

Here is another example of the same general type. The stiffening members are entirely above the cable, but connected with it. The cable forms a part of the stiffening truss, as it did in the preceding instance. The curve of the tension member along the lower limit of the bracing is a true parabola, symmetric about a center line. Straight lines are then run from the tops of the towers to the lowest point at the center. The Point Bridge at Pittsburg (Fig. 3) belongs to this type of structure. If the load is placed at the center, the two straight tension members carry it; if it is uniformly distributed from end to end, the parabolic cable is in position to take it without the aid of the bracing; and if the load is eccentric (over one-half the span, for instance), then the straight members act as the top chords of the stiffening trusses. The cable forms the lower chords of the stiffening trusses as they are needed, while the bracing carries such shears as may be required to be transferred between the straight chord members and the parabola. It is a very economic form of stiffening truss, although I doubt very much whether it may be economically applied to such short spans as the Point Bridge.

Another figure represents a bridge with two concentric cables equidistant apart at all points, as usually constructed, and with the bracing between them. The two cables are parabolic, and are capable of carrying any uniform load; while the bracing is so placed as to transfer shear from one to the other in case of an eccentric or unsymmetric loading. That is the form of stiffening truss which has been employed by Mr. Lindenthal in his design for the North River suspension bridge (Fig. 1), with which it is proposed to cross the North River from Twenty-second Street to the New Jersey shore, in one span of about 3,000 feet. That type of suspension bridge has been used already by Mr. Lindenthal at St. Louis and at Pittsburg. It has also been employed in Europe. It has not yet been employed for any very long spans.

There are certain difficulties which attend these designs, but they are neither insurmountable nor inconsistent with a high degree of economy. They arise from stresses produced by changes in temperature. Variations in temperature in the cables of a suspension bridge cause very considerable deflections, but as they occur in long spans, they do not sensibly affect the passage of traffic. The total movement at New York city of the lowest part of a cable for a 3,100-foot span may be as much as seven feet. As half that amount is the change of grade for half the span, i. e., 1,550 feet, it is seen that the deflection is not of material moment. What is more serious in the cases of

FIG. 3.—SUSPENSION BRIDGE WITH TRUSSED CABLES—THE POINT BRIDGE, PITTSBURG.

* An address delivered November 4, 1899, before the Engineers' Club, of Philadelphia. Revised by the author for the SCIENTIFIC AMERICAN SUPPLEMENT. The illustrations herewith given are supplied by the SCIENTIFIC AMERICAN to replace the views used at the lecture.

the stiffening members being placed along the cables is the temperature stresses which are developed in those members themselves, in all types of that class. They are not, however, beyond computation to a reasonable degree of accuracy, and need not be considered as any serious difficulty in the way of designing satisfactory structures. They have been computed in a number of cases; and while they exist to a considerable magnitude, they are not too great to be provided for with economic sections.

In order that any type of suspension bridge may be made practicable, it is desirable, I think, that some other method of forming the cables should be devised than that of slowly weaving them, so to speak, as has been done in all cases of wire cables to the present time. The matter of an improved method of laying the cables has received a good deal of serious attention, and I have little doubt that cables may be designed to be laid with all the accuracy that is required for such structures, in possibly one-third of the time that has been required in the old manner of construction. It is perhaps a little hazardous to express such an opinion without supporting it by explicit statements of methods of procedure; but enough has been done, I believe, to point to such results with certainty. At any rate, while we have seen what are really marvelous advances not only in the designing of ordinary truss bridges, but in their methods of erection, we have seen practically no progress in the design and erection of suspension bridges of considerable span in this country. That is a condition which has resulted from the fact that few suspension bridges have been built. There has been no such demand for them as for the ordinary truss bridge, and no such stimulation of devices and fertility of resource as have been developed in connection with ordinary bridge construction.

In the new theory of computations it is seen, as would be expected, but as it is not seen in the old theory, that the deeper the stiffening truss is made, the more of the moving load the stiffening truss carries as a truss, and the less duty the cable performs. The chief purpose, obviously, is to throw as much carrying duty on the cable with as little on the truss as possible. Consequently, the depth of a stiffening truss, not jointed at the center of the span, should be made just

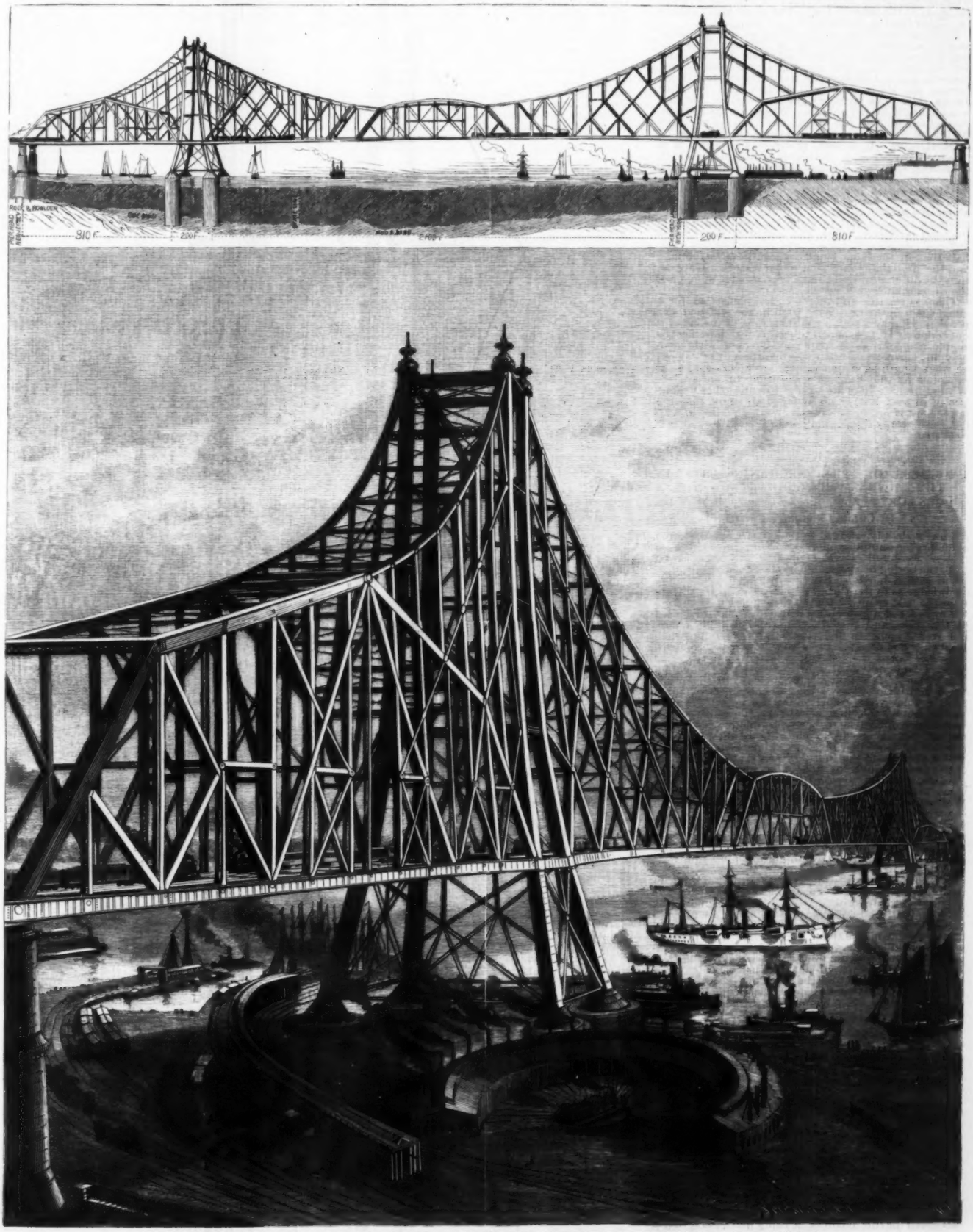


FIG. 4.—PIN-CONNECTED CANTILEVER TYPE—PROPOSED HUDSON RIVER BRIDGE. Span, 2,000 feet.

as little as is practicable to accomplish the purpose of such a truss. In other words, there must be depth enough to afford the requisite stiffness to keep the cable in its proper position, but no more; otherwise, a greater portion of the load is thrown on the stiffening truss, to be carried by it as a truss, which should be avoided. It is, perhaps, a little hazardous to state what should be the proper depth of truss in terms of the span at the present time; but it probably should be not far from $\frac{1}{75}$, perhaps, to $\frac{1}{50}$ of the span.

Probably the design of the cantilever was carried to as great a degree of excellence in the case of the proposed North River cantilever structure (Fig. 4) as any yet reached. The total length of clear span in this case was about 2,000 feet. It was proposed to put one pier in the Hudson River, 1,000 feet from the New Jersey side. The total weight of metal in that case was about 300,000,000 pounds. When this span was increased to 3,000 feet, the weight was increased to nearly 700,000,000 pounds, i. e., two and three-fourths times its original value. It is seen, therefore, that while it is feasible to construct a cantilever bridge of the length of span of 3,000 feet, it is not nearly as economic as the stiffened suspension bridge. The total weight of metal in the suspension bridge span of the same length, including the towers, chains and anchor plates, was about 300,000,000 pounds. Adding enough viaduct structure on each end to make the total length equal the total cantilever length, the weight of metal in the stiffened suspension system was materially less than half that in the same length of cantilever structure; and the probability was that under a more mature design the difference would have been greater in favor of the suspension bridge system.

There is greater stiffness, i. e., less deflection for a given span, in the cantilever than in the stiffened suspension system, although the deflection of the latter is not serious. It is an open question just how far the simple, non-continuous span may be used with economy in competition with the cantilever; or, again, at what length of span the cantilever ceases to be as economic as the stiffened suspension bridge system. While I hesitate to make a guess (because that is practically all that it is), I am inclined to think that the latter limit is somewhere in the vicinity of 1,400 to 1,600 feet for highway spans, and possibly 2,000 feet for railroad spans.

[Continued from SUPPLEMENT, No. 1252, page 20074.]

PROGRESS OF THE MECHANIC ARTS IN THE LAST THREE-QUARTERS OF A CENTURY.*

By COLEMAN SELLERS, M.D.

I HAVE already referred to the slow process of boring cylinders for pumping engines. When the early locomotives were built, for example in the Niles works in 1856, the boring of the cylinders was done on a 36-inch lathe with a horizontal boring bar, and without any knowledge as to the theory of boring in order to produce the best results. It always took two days to bore the cylinder of a locomotive of the size that they used at that time, and I think the largest cylinders were not over 15 inches in diameter. In Philadelphia, when Baldwin's had advanced to a very large establishment, they still bored the locomotive cylinders in the same way. It was not until shortly before the Centennial Exhibition of 1876 that attention was turned toward the utilization of a theory that had obtained in limited practice some years before as to the improvement in boring metals, the idea being that the quickest and best work can be done in boring by making the roughing cut with a fine feed, removing as much metal as possible by depth of cut, and making the finishing cut with a very broad feed but light cut that would let the cutter pass through the hole to be bored as quickly as possible, so as not to wear the cutting edge in passage. That principle was first introduced when Mr. Asa Whitney, of this city, discovered that chilled cast iron car wheels could be made to compete with the best wrought iron ones and do a greater mileage. If the wheels cast in an iron mould were not allowed to cool naturally, but taken red hot from the chill, were put into the annealing furnaces and brought up to a heat a little below the melting point, and then allowed slowly to cool, they were found to be free from all internal strains; while wheels taken red hot from the mould would burst into three or four pieces in cooling, showing that there was violent internal strain in metal cast in that way under the tension of the heavy chill on the outside of the tread of the rim. The problem of boring chilled wheels was solved by taking advantage of the fine roughing cut and coarse finishing feed. Mr. Whitney desired to have wheels made interchangeable in their fit on the standard axles, so that if a wheel were fitted on an axle at a workshop in Philadelphia, another wheel could be furnished to fit that same axle at any future time, and just as well as the first one.

When the late Mr. Hudson had charge of the Rogers Locomotive Works, he applied to the firm of William Sellers & Company to have a special locomotive cylinder boring machine designed and built, saying that he had seen a boring machine designed by Mr. Grant, of the Grant Locomotive Works, capable of boring a 19-inch cylinder in nine hours. The matter was referred to me, and when I came to calculate the theoretical time required for boring a cylinder of the size named, on the supposition that the speed of 16 feet per minute might be used in making the cuts, with a fine feed and a deep cut for the roughing cut and a shallow cut and a much wider feed for the finishing cut, I found that the calculated time summed up amounted in all to only three hours, and named three and one-half hours as not only possible, but what might be guaranteed as the productive output of such a machine. An order was given for this machine, it being understood that it was not only to bore the cylinders, but to counterbore the ends for the clearance of the piston, to cut off the sinking head and face up the flanges at each end of the cylinder. When completed, the first test was made with a 19-inch cylinder of hard close metal. This was bored in three hours and twenty minutes, exclusive of the time of setting the cylinder, which was not much on account of the peculiar arrangement of

* Address delivered at National Export Exposition before the mechanical section of the Franklin Institute, Philadelphia, on Thursday, October 5, 1899. Revised by the author.

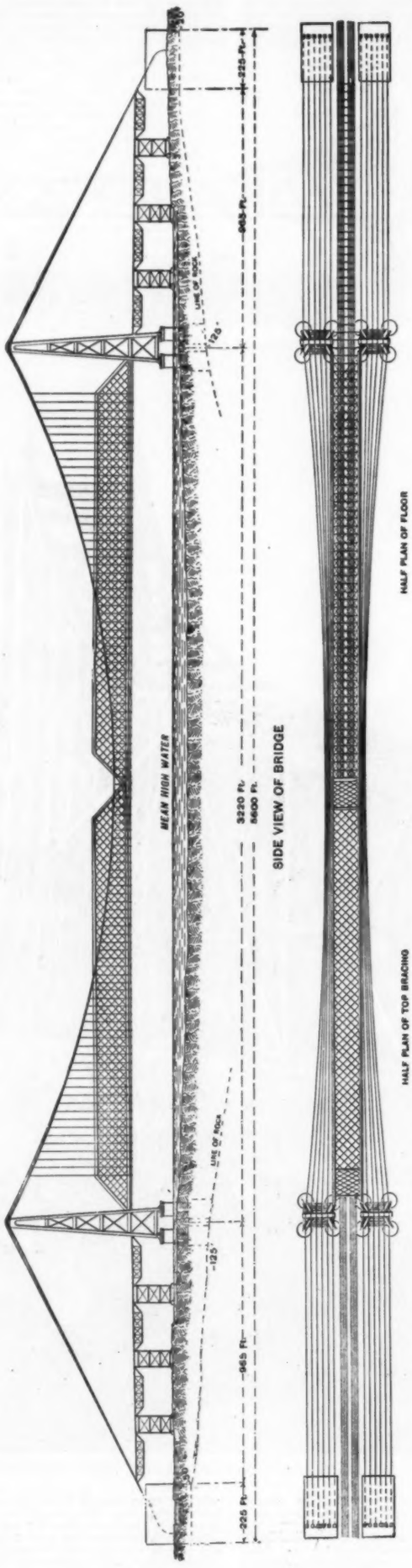


FIG. 5.—SUSPENSION BRIDGE WITH JOINTED STIFFENING TRUSS—PROPOSED HUDSON RIVER BRIDGE OF 3,100 FEET CLEAR SPAN.
RECOMMENDED BY THE SECRETARY OF WAR.

the machine and the facility with which the cylinder could be put in place for boring. In this case the cylinder stood still, while the boring bar traveled lengthwise, carrying the cutter head with it, and upon the two face plates of the driving heads of the machine were arranged automatic slide rests that faced off the flanges. In this design there was no guesswork, as the principle of fine feed and deep cut on roughing, with very coarse feed and shallow cut for finishing, was in common use in all operations of boring, turning, and planing metals, with exact knowledge as to what result was obtainable when the possible speed of cut per minute had been predetermined for the hardness of the metal to be tooled.

Since the time when I first related the incident of the rod planer in a paper published by me in The Engineering Magazine in 1892, even this tool, useful as it is, has been superseded almost wholly in locomotive works by improved milling machines. It is not my province to detail, step by step, the advance that has been made in machine tool building, but, as stated at the outset, I wish to make this industry illustrate the advance in the mechanic arts, and in connection with it I must call attention to the relative condition of the skilled workmen in American and in other countries. We owe much of our progress to our common school system, to our freedom from precedent, and to our just patent laws. I do not wish in the slightest degree to decry what has been done abroad, for I myself have been a close student of the progress of the mechanic arts the world over, and have been only too glad to recognize and avail myself of all that is good and worth adopting, assuming at the same time that improvement is possible and absolutely necessary in many cases to adapt the machinery designed abroad to the conditions that obtain in American workshops. The tendency to standardize everything is peculiar to this country. Builders of locomotives in America adopt standard sizes and types of locomotives, and are thus able to manufacture such to great advantage. Railroads in America are willing to take from the builders what has been shown to be good and effective, and when the same kind of machine is to be repeated many times, the maker can afford to invest heavily in special gages and special tools that decrease the amount of manual skill required in laying out the work or working to drawings. The first time a piece of work is done, whether it be small or large, simple or complex, more time is spent upon it than after the workmen have become familiar with its construction, and certainly more time than would be spent after special appliances have been invented and made to cheapen the product, especially when the men are paid for their work according to the quality and quantity turned out, and not by a fixed wage per diem. I allude to this because I know it is the custom of foreign railroads to submit to builders in England and America specifications for engines that cannot compete in economy of construction with those that are built in quantities in the way that I have just mentioned. It is the recognition of this fact that is now opening the markets of Europe to American locomotives as they are built and as they are used in America. A celebrated builder of locomotives in England told me that the rules of the Board of Trade and parliamentary regulations for the safety of the people crowded their locomotives with useless appliances. A close observer of railroad machinery who is familiar with all the railroads in the world has stated that if a locomotive builder abroad is given a new problem, such as to construct a hill-climbing freight engine or a goods engine, as it is called abroad, or even an express passenger engine for mountain districts, a completed machine may be the result that is a model of strength and durability, but inaccessible in the extreme when ordinary repairs are required. It is easier to take out the cylinders in an American engine and replace them with new ones than it is to reset the valves on the type in general use abroad, where the valve chests are crowded together under the smokestacks as though they would never require adjustment or resetting. The persistency evinced in adhering to the crank axle in English engines, in spite of its weakness, is one of the matters not understood in this country. Give accessibility to the valves and ready access to all the parts, and the whole engine will be better cared for by those in charge of it.

It has been the scientific methods introduced by the managers of the railroads, aided by the skill and perfect equipment in their workshops, that have made those great railway systems what they now are. They must exercise the utmost caution in all that they undertake; every alteration or deviation from adopted standards involves so many pieces that must be changed. In regard to the simple matter of making brakeshoes for the cars, and boxes for axle journals, I know from my own experience that it was not until the introduction of machines for moulding these pieces accurately that the best results could be obtained and the parts made exact and perfectly interchangeable. Every invention, whether it be in the foundry or in the machine shop, is cumulative, and has its effect upon other trades, and through our ingenuity and progress we have now reached a point when the whole world looks to America for certain work, which it seems cannot be done to equal advantage in other countries.

Dr. John Anderson, then in charge of the Woolwich Arsenal, England, was sent to this country to visit the Centennial Exposition in 1876, and besides acting as one of the judges of the machine tool exhibit, he made an official report as British Commissioner to both houses of Parliament. Prominent in these reports there will be found one on "Machines and Tools for Working Metal, Wood and Stone at the Philadelphia Exhibition," in which the following statement occurs:

"Great Britain certainly can claim the credit of having been the birthplace of modern machine tools, and has done wonders in raising the mechanical standard of perfection, and her influence for good in the advance of civilization thereby is incalculable. But when we consider the enormously greater area of the American continent, it is a matter of vast importance that tools have taken such a hold of the American mind, which will influence the civilization of the Western world for ages to come, and will exercise a powerful effect, not only on that continent, but on Australia, China, and the world generally; this, therefore, has a profound significance which can scarcely be overrated." Again he said: "The display of machine tools made by the United States was so vast that only the more salient points can be noticed in a brief report. It showed certainly that the past century has not been passed in idleness; and, judging by the enormous stride made by them during the past few years, it showed that they have been intelligent students of the best European authorities. It is true to say, however, that the Americans, as a rule, are not copyists; the inventing of clever devices and tools for saving labor seems to be their natural forte, and worthy of the old stock, probably quickened by the peculiarly favorable circumstances under which they live. It was the display made in this section which most conspicuously brought out the enormous strength of America as a producing power. More than a hundred exhibitors had each a large exhibit that commanded the admiration of all who took the trouble to examine them in detail. In this vast array were machines for all purposes, small arms, ammunition, sewing machines, clocks, watches, and all the branches of machine making and engineering, and almost all were finished in a style superior to that of any former exhibition."

In the early practice of the first quarter of this century, scientific methods did not obtain. There was little technical literature to help the designer, and the best results which have made American ingenuity appreciated the world over were brought about through careful experiments and earnest effort on original lines. The history of the steam engine, so far as the American types are concerned, was clearly not the outcome of the books, for the theory thus taught under the head of thermo-dynamics is really a description of what had been accomplished, rather than the cause of development. The need of technical schools was early felt, but the want was not supplied until the generosity of individuals rendered the foundation of special technical schools possible. The government cannot be looked upon to aid in such enterprises in the United States as it can in England; yet up to 1884 in London there was no technical school in existence that in any way compared with those at Hoboken and Boston in this country, while engineering is now taught in our older universities. At a dinner given to the members of the Institution of Civil Engineers in 1884, Sir Lyon Playfair, in responding to the toast of "The Universities of Scotland," after those of England had already been discussed by able speakers, astonished his audience by refusing to speak to the toast directly, and entered a strong plea for technical education in England, such as existed at that time in the United States. He said they should not look to Germany and France for examples of technical schools, but across the Atlantic, where those speaking their own language had already put into practice what England had so long needed. While the speaker was doubtless correct as to the wants at that time in Great Britain, the technical school of South Kensington was then being established, and the Guilds of London had contributed freely toward its support. Good work has been done by these and other schools and by the trade schools that have started in various parts of England; but there is, in my opinion, a very great difference between the character of the young men who seek technical education in England and those who leave the workshop to obtain a knowledge that is so absolutely neces-

FIG. 6.—THE NEW TOWER BRIDGE, LONDON—THE BASCULES OPEN.

sary to every educated engineer in America at the present time.

We are long past the period of empirical work. The steel makers and iron founders now depend upon metallurgists to guide them, while every well equipped machine shop in the country must have its staff of educated men who are able to reinforce the practical knowledge of those at the head of the establishment by exact mathematical methods that were in the early stages of our work limited to simple arithmetic.

As indicative of the necessity of education on the part of the working classes, I have known instances in which labor-saving machinery that was doing good work in America, cheapening the output in a particular class of hardware, when introduced into England failed entirely and brought discredit to the member of the firm who had advised its purchase. A gentleman interested called upon me after the failure of the machinery and solicited letters enabling him to visit some of the industrial establishments in the United States. Upon his return from these places he told me that all that had been said about the character of the work done by the machines not only had been confirmed, but that its merits had been underestimated. He said, however, that it was, in his opinion, impossible to utilize it with the workmen they could obtain in England, owing to trade prejudice and trades union regulations. What the peculiar conditions were I am unable to say, but what I wish particularly to impress upon my hearers in this respect is that in his opinion the difference in the character of our workmen and workingmen of the same trades in England is wholly due to the better education of the Americans, who are fully two generations ahead of those abroad. It is perfectly evident that it is impossible to raise the standard of work by means of labor-saving machinery unless the workingmen themselves will see the advantage derived from their ability to do more and better work, and thereby obtain better wages. This is particularly the case when they are called upon in this country to operate machines that do not require the constant attention of a man, but where it is possible for one man to attend several machines and earn higher wages than he possibly could if compelled to stand idly watching a machine that required but a small portion of his time to attend to it. There would be no inducement to contrive automatic machinery unless those who use such machinery are able without prejudice to take advantage of the saving in labor attainable thereby.

Ship building all over the world since the first iron vessels were launched shows by the constantly improved output the wonderful progress in scientific knowledge, and in manual as well as mechanical skill. The great fighting machines for the ocean have been improved with astonishing rapidity. This year our own output in that line has for the first time been tested and found good, when handled by such men as we as a nation may feel proud of. The nations have been increasing the power of their fighting ships year by year, adding new improvements in machinery, new means of resisting attack from other ships, new guns and newer projectiles to pierce the new armor plate, and let us hope with decreasing opportunity to bring the results to actual test in battle. In our own recent experience, practice at great cost found our trained marine force better equipped for the operation of these fighting machines, and in the far East and in the West Indies our guns swept a maritime power out of existence with, upon our part, scarce the loss of a man.

In working iron and steel the introduction of the Whitworth forging press marked an important advance compared with the costly steam hammers; and hydraulic presses became absolutely essential in perfecting the American type of link and pin bridge construction. Some of the forgings required for the 5,000 horse power dynamos needed by the Niagara Falls Power Company could not have been executed by means of any existing steam hammer in this country or elsewhere. The Bethlehem Steel Company were the first to introduce this system of forging on a large scale. Forging by pressure in place of impact by hammers enables the force required to cause a given deformation of metal to be accomplished with the least expenditure of power and greater exactness, as was soon manifested in the readiness with which hollow shafts were produced. About 1893 the work at Niagara Falls called for steel rings of absolutely uniform density, having an outside diameter of 11 feet 4 inches with a width on the face of approximately 50 inches, and a thickness of over 5 inches, which necessitated the use of a press of greater capacity than any heretofore erected. The press at Bethlehem combined with the Whitworth system of compressed steel ingots was taxed to its utmost to make what was needed in this case. It is interesting to note that this work was the first product of machinery introduced mainly to furnish armor plates and the massive steel forgings needed for our modern ships of war.

The plant of the Niagara Falls Power Company offers evidence enough of the remarkable progress that has been made, not only in the mechanic arts, but in the high scientific ability required to design machines that had no precedent in size or in exact requirements as expressed in the specifications predetermining each requirement as to the results to be accomplished. Thus the designers of the dynamos were called upon to guarantee an output from each unit of power with so high an efficiency that all the magnetic and electric losses in the machine would not amount to over 2½ per cent. This promise was fulfilled, and when subsequent machines were required, the result was even more favorable than in the first instance. The final result is the crucial test of all progress; and certainly we have throughout those of our industries which require mechanical skill and precision sufficient evidence of the marvelous progress that has been achieved during the past seventy-five years.

As I have taken occasion to mention the work at Niagara Falls, which has engaged so much of my attention, it may interest those who are not familiar with the results of this undertaking to hear something further in regard to it. At Niagara Falls we had for the first time to construct a tunnel that as a tail race would be adapted to the development of 100,000 horse power. The International Niagara Commission had decided that 5,000 horse power was to be the unit, and the plant was accordingly laid out on this basis. It was assumed that water wheels could be made of that capacity and could be placed 150 feet below the level of the dynamos to be operated, where, as one of the commissioners suggested, the length of shaft would be about the same as between the propeller and engines of an ocean steamship. In the practical solution of this problem we were obliged to have similar thrust bearings to guide the shaft; but the construction of the turbines is such that the water under the upper wheel of the two in the case is made to buoy up the whole mass of about 160,000 pounds. The dynamo at the upper end of the shaft therefore practically spins on a cushion of water with only a pressure of 3,000 pounds more or less on the thrust bearing rings, according to the variations in the velocity, as the power developed is increased or decreased.

It is too large a subject to permit me to refer in detail to all of the work that had to be done at Niagara Falls; but I want to say that while our constant effort has been to interest the manufacturers of machinery to make designs that they could guarantee, a great deal of designing has been necessary by the engineers of the company, most of which was experimental, and that no failures should have been experienced is most satisfactory, when I realize how little precedent we had to guide us, and the risk attending the solution of the problem as it was presented to me.

As regards the utilization of the power being developed at Niagara Falls, it may interest you to note that we hope shortly to have ten dynamos running, each of 5,000 horse power nominal capacity, but actually capable of delivering over 5,300 horse power each. The first three turbines that were installed in accordance with the design of the builders had to be materially altered; and I have introduced improvements of my own invention to make them fully successful as far as the shaft transmission was concerned. These modifications were made in the five units that were subsequently installed; and, without any change in the water wheels, the efficiency was increased so that they delivered 5,500 electrical horse power each instead of 5,300 horse power, which was the output before the changes were made.

As now constructed, all the electrical and magnetic losses in each of the dynamos aggregate but 2½ per cent., and you can judge what the efficiency of the water wheels must be when those which at 75 per cent. efficiency would give 5,300 horse power are now driving dynamos that deliver 5,500 horse power without any changes in the wheel, but only such alterations in seemingly immaterial parts as the design of the connection between the water wheels and the dynamos.

The first industry established in connection with the plant was a paper company, which required 7,200 horse power, but it installed its own wheels on land of the power company and utilized the latter's tunnel and canal facilities. Next followed the Pittsburg Reduction Company, which takes 8,550 electrical horse power for the manufacture of aluminium. The Carborundum Company for making abrasives takes 1030 electrical horse power. The Union Carbide Company 5,000 electrical horse power for the manufacture of carbide of calcium. The Niagara Electro Chemical Company, making peroxide of sodium, that is, metallic sodium, takes 400 electrical horse power. These and other works now in operation or being installed will utilize possibly by the first of next year a total of 41,000 horse power. Most of these establishments are electro-chemical or metallurgical in their processes, and have sprung into existence with the development of hydro-electric power, although they are based upon principles which were discovered years ago. The metal sodium, for example, is made commercially by practically the same process as was employed by Sir Humphry Davy when he first began experimenting with the galvanic battery for the reduction of metals. The alternating current that has been adopted in the machines that generate this electricity is the alternating current as studied by Michael Faraday. The change in the potential from 2,200 volts at the machine to 11,000 volts in transmission is effected by the transformers that were discovered by Faraday, and were formerly used most in Ruhmkorff coils and other philosophical instruments. The principle was known, and then it became useful for lighting purposes when the alternating current took its place in the lighting of cities.

In the problem presented at Niagara Falls we had to provide for direct current to operate railroads and for electro-metallurgical purposes. This power is developed as alternating current, and transformed from two phase into three phase by an invention of Mr. C. F. Scott, of the Westinghouse Company.

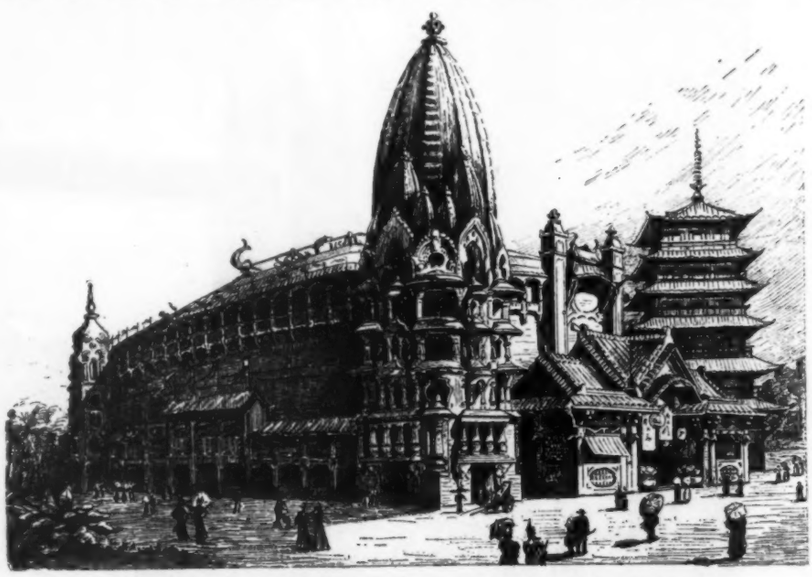
It is a noteworthy fact that since the first wheels were started in 1895, there have been no stoppages of more than an hour or two at the most. The plant has been in operation night and day, carrying on processes that permit of no interruption on account of the loss which would result.

I regret that I cannot discuss this subject at greater length, for the machinery and appliances installed at Niagara Falls, as well as the industries which have resulted from the development, have made the enterprise one of the most important achievements of the period we have under consideration.

Reviewing the century's progress, one cannot but be impressed with the tendency to specialize all industries. It has been truly said that jobbing shops are and always will be a necessity, but that manufacturing establishments will lead in the march of improvement. Trades are becoming more diversified, and time, talent, and capital are being expended upon individual machines and appliances which were formerly but a part of the outfit of single establishments. To this concentration of the best thought upon special branches of all industries, we may attribute much of the progress in the mechanic arts made during the past seventy-five years, which has opened the markets of the world to the products of our industry. The influence of the Franklin Institute has played no small part in this progress, and as one long identified with its work I extend my greeting to its members, hoping they will continue the usefulness of an institution which bears the name of one of the greatest philosophers that America if not the world has produced.

THE DIORAMIC PANORAMA OF THE EXPOSITION OF 1900.

AMONG the attractions of the Exposition of 1900 will be a dioramic panorama called the "Tour du Monde." The perspectives of a background of canvas will carry the spectator successively, by vision, over different parts of the globe. Scenes appropriate to each country, and showing in the foreground persons dressed in their native costumes, and engaged in their usual daily occupations, will complete the whole and give each picture an intensity of local color which, brought into relief by the combined effects of light, will produce the impression of reality.



BUILDING FOR THE EXHIBITION OF THE DIORAMIC PANORAMA.

It is in this way that the spectator will traverse Greece, Turkey, Syria, the Isthmus of Suez, India, China and Japan, and, returning, reach the banks of the Bidassoa, in Spain.

The stages of such a journey have been selected from among the places that are the most remarkable and most capable of satisfying the curiosity of the spectator.

In Greece, it will be Athens. The modern city will appear on the horizon under the sun of Attica, while nearer by, the Parthenon and the Acropolis will exhibit upon a transparent sky the profile of their imposing structure. Then it will be Constantinople with its magnificent edifices, including the famous mosque of St. Sophia; and the Bosphorus and its blue waters covered with vessels of all kinds and bordered by dwellings that are reflected therein in long white rows.

The solitudes of Syria, the ruins of Baalbec and the ancient Heliopolis will succeed these sites of a melancholy captivity and lead us, in Egypt, to a village of Fellahs situated upon an eminence. In a deep valley we shall see Port Said and Cairo; and the Suez Canal will be observed losing itself in a mist. Far away to the south will be perceived Abyssinia and the circular camp of Addis-Ababa.

In Ceylon, beneath the shade of a banyan that throws its great branches to a distance like so many columns designed to sustain its dense mass of foliage, we shall see snake charmers and Hindoos that astonish us by their games and their feats of legerdemain.

In Indo-China, amid vegetation surpassing anything that our imagination can conceive of in the way of the wonderful, we shall see the outlines of the temple of Angkor-Watt, along with other ruins emerging upon the left from a curtain of flowering vines.

At Shanghai, in China, some natives will receive us

in front of a sumptuous dwelling surrounded by a garden of odd appearance. It is the "Garden of Stones."

In Japan, the scene will be delightful. We shall enter a tea-house, in which Japanese women well receive us, wait upon us and dance for us. We shall see a garden planted with ancient dwarf trees, and a small river flowing in cascades to the neighboring woods. In the horizon will be perceived the famous volcano of Fusi-Yama.

In Spain, we shall witness the various steps of the bolero and fandango, which offer so marked a contrast to the supple and grave circle dances of the East.

Independently of the panorama, properly so called, a series of curious points of view will complete the whole. Among such compositions we shall find the ramps of the Compagnie des Messageries Maritimes, the shops of the Ciotat, the agency of Saignon and the banks of the Donai.

This interesting attraction will be surrounded by all the amusements desirable—theater, shops, restaurants, etc.

The elements of the external decoration of the building in which the dioramic panorama is to be exhibited will recall the architecture of the countries represented upon the canvas within. As a whole, they are whimsical and incongruous, and yet are well calculated to attract the attention of the public, to which the novel and the unexpected are always suggestive.

For the above particulars and the engraving we are indebted to Le Magasin Pittoresque.

HIGH TENSIONS AND THE TRANSMISSION OF ELECTRIC ENERGY.

SEVERAL of our subscribers, says La Nature, have asked us for some information as to how high a tension can now be reached for the transmission of electric energy. The question is an important one and has been the subject of much study since the publication by The Electrical World, in 1898, of a paper presented to the American Institute of Electrical Engineers, at

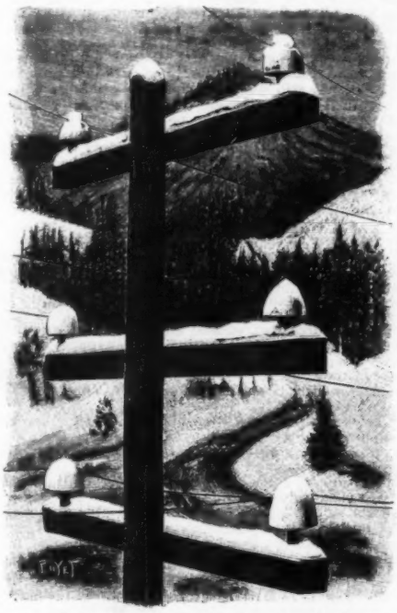


FIG. 1.—GLASS AND PORCELAIN INSULATORS FIXED UPON ARMS ATTACHED TO POLES.

Omaha, by Mr. Charles Scott, chief electrician of the Westinghouse Electric and Manufacturing Company.

We shall endeavor to make a résumé of this paper and give its conclusions.

In 1891, the Westinghouse Company made an installation of a transmission of motive force of 10,000 volts between San Bernardino and Pomona, in California. In the first place, it tried transformers, and afterward resolved to make some experiments on high tension upon insulators and lines. With insulators mounted upon wood and with an efficient difference of potential of 50,000 volts, the loss was about 2 watts per insulator. Very numerous experiments were made with nine wires, 60 feet in length, placed horizontally and parallel at a distance of 4 inches apart, and supplied by currents of a frequency of 60 and 135 periods per second. The losses were slight up to 20,000 volts, but afterward increased till they reached about 1,200 watts for 30,000 volts. The losses diminished rapidly in measure as the distance increased; and it was found that the loss for the distance of 4 inches and at 28,000 volts was the same as the loss for that of 16 inches and at 36,000 volts. It was likewise observed with the wires that starting from 20,000 volts, they commenced to become luminous and to hiss, and that the luminous sheath and the sound gradually increased, while the experimental hall became charged with ozone.

Some new experiments were afterward made between the central generating station at Ames, Colorado, and Gold King Mill, at a distance of about two and a quarter miles. A synchronous motor of 100 horse power was installed in the mill, and the energy was transmitted at the most varied differences of potential. The line, which was formed of iron wire, 0·156 of an inch in diameter, was fixed upon glass and porcelain insulators, carried upon 62 poles, each provided with three arms (Fig. 1), the highest of which was 26·25 feet above ground. Each arm carried two insulators of the same type; the upper arm, two large glass ones; the intermediate arm, two small glass ones; and the lower arm, two large porcelain ones. Fig. 2 shows the details of the insulators tried.

The experiments were made in December, 1895, with a tension of from 25,000 to 33,000 volts, now empty and now at the charge of 100 horse power mentioned above. In January, 1896, the tension was raised to 45,000 volts for seven days, and, at the end of the month of March, there were begun some experiments at 50,000 volts that lasted thirty-seven days in succession, and that were interrupted only by the damaging of a transformer by a stroke of lightning.

During these experiments, says the report, the climatic conditions were at times very unfavorable, since violent wind storms, clouds of dust, snow (sometimes wet), and rain occurred. At 50,000 volts the wires were plainly visible during the night; and at a distance of several hundred yards was heard the hissing characteristic of currents of a high tension. A few measurements were made at this time, and it was found that the losses were feeble below 45,000 volts, but rapidly increased beyond 50,000, and reached 16·4 kilowatts at 59,000.

Similar experiments were made at Pittsburg and Niagara, and the results obtained were the same.

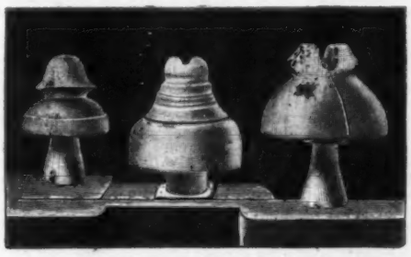


FIG. 2.—INSULATORS TRIED WITH HIGH TENSION AT AMES, COLORADO.

Among the present high tension transmissions may be mentioned the installation at Provo, Utah, of the Telluride Power Transmission, which transmits a power of 500 kilowatts at an efficient difference of potential of 40,000 volts to a distance of 33½ miles. Fig. 3 (No. 1) shows the type of insulator used by the Colorado Electric Power Company, which transmits power at 20,000 volts.

It is of interest to give, in a few words, the conclusions that the Americans have drawn from their experiments. Upon a high tension line, the losses by insulators are of slight consequence, and the losses by wires are feeble in climates in which the air is pure. In a transmission there is always a maximum tension that is the most economical. Porcelain and glass insulators have, both of them, their advantages and their disadvantages, which are comparable. It is estimated that the distance to which a given power can be economically transmitted is equal to about five times the efficient tension in kilowatts. The power to be transmitted is also limited to a given distance by reason of economy.

These experiments are truly important, and teach us that, in the present state of science, electric transmissions of energy can be made at 50,000 volts to distances of 180 miles.

ELECTRIC VEHICLES AND THEIR RELATION TO CENTRAL STATIONS.*

By H. M. MAXIM.

THE rapid advance being made by the electric motor wagon directs the attention of those interested in central station matters to the probable effect of this new industry upon central station affairs. An investigation has been made into the question, and it is thought that the results stated as briefly as possible may be of some interest at this time.

The battery is, of course, the prime consideration in an electric automobile. The conditions to which a storage battery is subjected in this service are probably as severe as any existing, and it is only recently that battery manufacturers have given due attention to the production of a type of cell specially suited to this work. The prime conditions to be fulfilled are evidently lightness and compactness, but in addition to these must be added ability to regularly withstand heavy currents of charge and discharge without buckling or disintegration, and general durability to offset the mild abuse which, under the present conditions of popular knowledge respecting the storage batteries, seems inseparable from its general and indiscriminate use by the public.

The type of battery giving the greatest capacity per pound, apart from other considerations, is probably found in some form of pasted cell, and the future battery for motor carriage work is quite likely to be a high capacity, durable cell of this type; but there are objections to all existing forms of pasted cells on the score of delicacy and short life, and the Pope Manufacturing Company and the foremost American makers, after testing the principal types both here and abroad, have almost universally adopted a combination type of cell as nearly fulfilling the requirements.

The present state of the art requires that a cell, in order to be of any value, should show a capacity of from 3·5 to 4 ampere hours per pound of cell complete with lugs, jar, etc., at a discharge rate of not less than 1·3 amperes per pound of complete cell. It must, furthermore, be possible during discharge to increase this rate to 4 or 5 amperes per pound of cell for short periods, without injury, and to charge it from empty to full in three hours, or thereabouts. With a battery coming up to these specifications, a mileage of thirty-five can be obtained under favorable road conditions with an electric phaeton seating two people before the point of injurious exhaustion has been approached. This performance can be, and has been, greatly surpassed by the use of high capacity cells of short life, and a run of 92 miles is actually reported from Paris, but this practice is generally condemned by American engineers as removing the electric carriage too far from the field of practical utility by the use of a battery incapable of rough usage and economically useless through its short life. In France several firms are engaged in the business of letting out or caring for vehicles fitted with high capacity batteries, the great demand for which enables them to charge such rates as to realize adequate profits in spite of the frequent renewals of the short life cells. The conditions which admit of this practice are plainly of a temporary nature, and American builders have, we believe, with good reason, refused to lose sight of the practical features of this question for any mere considerations of temporary profit.

The usual American practice is to equip a vehicle with forty-four cells in rubber jars, four groups being formed by boxing together eleven cells. This makes a combination which can be charged from a 110-volt circuit, and three speeds can be obtained by merely changing the grouping of the boxes and the consequent voltage applied at the motor terminals. Thus, with all four groups in multiple at a reasonable discharge rate approximately 22 volts are obtained, 2 in multiple and 2 in series gives 44 volts and double the speed, while with all in series the full voltage of the battery is reached. The combinations of resistances and alterations in the field connections of the motors can, of course, be used for further speed variation, but many of the best types of carriages find the simple changes in the cell groupings ample for all purposes, a manipulation of the controller lever and the increasing and diminishing momentum of the carriage affording numberless gradations of speed once thought obtainable only through a large number of controller steps.

Series motors are in general use, employment sometimes being made on the same carriage of two motors mechanically separate, but series connected, each geared to its own driving wheel. In this way an electrical balance of the driving power is obtained between the driving wheels, and the alternative of a mechanical balance is obviated. Experience has shown this, however, to be an advantage only in special cases.

Let us take for discussion a single-seated Columbia phaeton, as this represents a common type, is built by a well known firm, and may fairly be regarded as the standard of the day in its own field. This carriage complete weighs approximately 2,000 pounds, 45 per cent. of which is due to the battery. The controlling apparatus consists of a foot lever connected to a band brake, a steering lever at the driver's right hand, the controlling lever at his left, a push button for an electric signal bell in the controller handle, and a foot reversing lever used only preliminary to backing. This carriage is at all times under the perfect control of the driver, and can be turned in a 26-foot circle, and can be stopped on the level when going at a rate of 10 miles per hour within 25 feet from the point of application of the brake, if the occasion demands, ignoring the wear upon the tires. It can be operated with ease by persons without previous experience; a woman's strength is, and frequently has been, sufficient to completely control it, and for the average individual but a few hours' trial is necessary to give skill and familiarity in all phases of its operation. Its simplicity and flexibil-

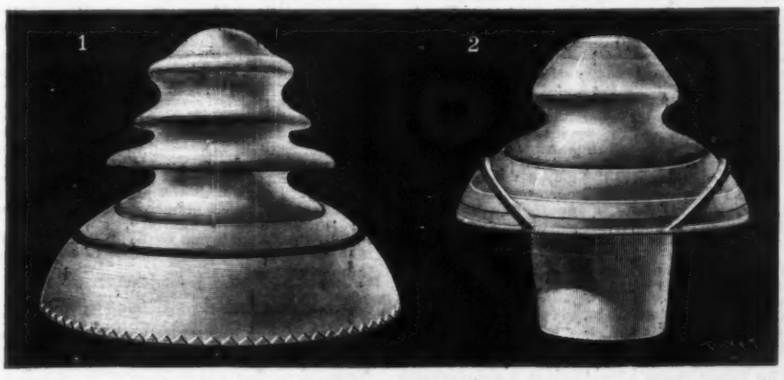


FIG. 3.—TYPES OF INSULATORS.

1. Insulator tried at Provo at 40,000 volts. 2. Insulator employed by the Colorado Electric Power Company.

* Abstract of paper presented before Northwestern Electrical Association, Milwaukee, January, 1900.—From The Electrical World.

ity is a very good illustration of what can be done with electricity when properly applied to a vehicle.

The batteries can be charged inside the vehicle when the service demands. To this end each carriage is provided with a flexible conducting cable to connect with the source of supply, terminating in plugs of different diameters. These plugs fit into corresponding receptacles at the rear of the carriage, and in no way can a mistake be made in inserting them owing to the difference in size. Better care can, of course, be given the batteries when removed and exposed to the view of the attendant, and this is ordinarily done when possible.

The battery is placed upon the 110-volt circuit with the interposition of a sufficient resistance to bring the current down to 40 amperes for this particular type, at which point it is maintained until the voltage has risen to 110, when the current is allowed to diminish until it has reached but a few amperes. This method completes the charge from empty to full in three hours. Automatic features for cutting out the battery when full have been introduced with success by combining a recording wattmeter with a cut-out magnet. This wattmeter registers the watt hours of discharge by a movement of the pointer in one direction, while the charge is recorded by an opposite movement of the pointer, each scale division on the return movement, however, corresponding to a sufficiently increased number of watt hours to adequately provide for the average internal loss in the batteries, so that when the zero or full position of the scale is reached on charge the batteries are again in a fully charged condition, and a contact is made which operates the cut-out. As popular knowledge respecting storage batteries increases, however, it is probable that devices of this nature will be eliminated for the sake of simplification, and used only occasionally; for it is found that a little familiarity with the subject enables one to form a most accurate estimate from mere observation as to when the fully charged condition has been reached by a battery.

As regards discharge, one's senses soon become so trained that a very accurate determination of the voltage, and hence the condition of the batteries, can be made by noting the diminishing speed of the carriage, slight as it is. The capacity and the general working of a storage battery are more or less modified by conditions of temperature, etc., due allowance for which cannot be made by any recording instrument, and one's observation becomes after a little experience the simplest and most complete battery indicator.

It has been found by experience that the average coachman or caretaker, after a week's instruction, is competent to care for an electric carriage. With the exception of the batteries, the attention required is no more than that necessary for an ordinary horse vehicle, and no more complicated than that given a bicycle, and the mere routine of charging the batteries and maintaining the electrolyte at the proper specific gravity is soon learned.

When we come to the application of electricity to the delivery business, it might seem at first as if a vehicle reaching its limit of continuous mileage in the thirties were laboring at a disadvantage. This is not the case. An investigation of the daily mileage of the busiest delivery wagons of some of the largest houses shows that rarely does a wagon accomplish 18 miles on a single trip, and that a considerable interval invariably elapses between trips. Thus, not only is the mileage sufficient, but delivery wagons built for light goods delivery are at present designed for a minimum mileage of 25, thereby gaining decreased battery weight. The interval elapsing between trips is utilized to charge the batteries in the wagon, which requires approximately two hours, for they are but partially exhausted. An excellent example of the advantages of this class of services is shown by an electric mail van used by the post office authorities in London. This van makes six trips per day between the main and branch office, a total mileage of 40, with one set of batteries. On each trip it carries about 1,200 pounds of mail matter. Actual tests of the power consumption of the heavier class of electric vehicles show that 65 watt hours per 1,000 pounds per mile at a speed of 10·5 miles per hour is a conservative estimate, in fact, probably rather high, as these figures were obtained over suburban roads, and not on hard pavements. The expenditure necessary to recuperate the batteries may be liberally estimated at 100 watt hours per 1,000 pounds per mile.

The following delivery wagon actually built, a good example of the dry goods type, may be considered in this connection: Total weight, loaded, 4,500 pounds, including weight of two drivers and 1,000 pounds of useful load; maximum mileage, 25; weight of batteries, 1,300 pounds. From the above considerations the expense of running this wagon on a 15-mile trip would be the cost of 6·75 kilowatt hours, and 13·5 kilowatt hours for two trips. From figures obtained from prominent retailers in the large Eastern cities, it appears that the cost of stabling one delivery horse at the owner's stable, cost of shoeing and repairs for harness, amount to $350 per year, and as an electric delivery wagon can be run continuously save for short intervals of recuperation, and can therefore do the work of two horses, double this amount, or $700 per year, is the expenditure for the operation of equivalent horse service. On a basis of two trips per day for the electric wagon, the yearly expense of operation, allowing 300 working days to the year, is that of 4,050 kilowatt hours. Any reasonable price for power leaves a considerable margin in favor of the electric carriage.

The custom of the large retailers is to dispatch fresh deliveries at frequent intervals. These are divided into several classes: some go to the extreme range of distance, others go but a few miles, and returning quickly make a large number of trips during the day. Starting in the morning, then, with the batteries fresh, no charging current would be required until the first short trip had been finished, when each battery as it is connected to the charging mains would take 50 amperes. This current would soon diminish for a single battery, but as the separate sets would be connected in and cut out from this time on, a fairly constant load could be expected until midday, when there would probably be more or less of a peak. This would be followed by an afternoon load and another peak at the close of the day. This, of course, is merely a general supposition as to the power consumption of one large concern. The use of electric wagons by a large number of smaller concerns operating under different programmes—a situation which the majority of central stations is more likely to meet—ought to effect a day load approximating a fair degree of constancy.

The operation of a cab or omnibus system would work to even greater advantage to the central station. An omnibus system planned for one of our central cities provides for nine vehicles, each carrying twelve persons and running under a headway of five minutes. The route to be traversed will necessitate the expenditure of about one-half the charge of the battery, so that each set can be brought to the full condition in two hours or less. This would, of course, necessitate a change of battery for each trip, and, when running on a five minute schedule, a total of twenty-four sets of batteries constantly on the line. At the end of every five minutes a set would be cut out and a new one put on in its place. This would cause a load of approximately 930 amperes, diminishing to 880 at the end of five minutes, when it would again rise to the maximum.

The demand for omnibus service in many places, especially in certain localities where for æsthetic reasons the trolley lines are excluded, is without doubt a real one, and will within the next twelve months call for the equipment of many such lines. The success in many instances must rest in a measure upon the co-operation which the central-station owners afford, and it would seem that the desirability of increasing the day consumption of power and the ultimate immensity of this demand would invite their most favorable attention. The consumption of day loads by electric vehicles offers such manifest advantages that the lowest possible rate should be made this class of customers for the encouragement of the industry and from considerations of its coming importance. Prices for charging current for storage batteries vary over a considerable range, partly on account of the differing conditions of day load in different localities, but mainly owing to the novelty of the service, which would necessarily tend to make the price uncertain; but as an indication of what can be accomplished, one of our largest cities considers the day load which is gained by this service to fully warrant it in offering current at two and one-half cents per kilowatt hour, of course in reasonable quantities.

An important aid in popularizing the electric motor vehicle would be rendered by central-station owners were they to provide their plants with the apparatus necessary to charge a carriage, and thereby invite public confidence in the existence of charging facilities at all stations, thus relieving the technically uninformed man of much anxiety and care when he is obliged to cover unknown territory with his vehicle. Quite an important and novel feature in this connection is the use which will shortly be made in New York, and will be capable of indefinite extension, of a so-called charging "hydrant." This is now being perfected by a prominent electric company, and consists of a coin-controlled mechanism with a wattmeter, voltmeter, rheostat, switch and terminals, such that the driver of an electric vehicle, after having deposited the necessary coin in a slot, can draw upon it for a certain number of watt hours. The general adoption of some such device as this, and the certainty of finding it in different localities of a city, would greatly encourage the general use of electric automobiles.

The smaller plants within twenty-five or thirty miles of each other will feel the influence of the pleasure carriage, and regularly established touring routes will soon be a fact through those localities where the lighting stations have had foresight to provide themselves with facilities for charging. Many central-station managers have needed no light to point them the way. The station of the Central Railway and Electric Company, at New Britain, Conn., provided itself with facilities for charging itinerant electric vehicles nearly two years ago. In alternating plants, if possible, means should be provided for obtaining direct current from some other source than the exciters—either a direct-current machine or a rotary transformer. A small recording wattmeter would be found a valuable adjunct, while a voltmeter, small rheostat, switch and charging leads would comprise the list of essentials.

After all, we are mainly interested in the appearance of the ledger. The greatest financial problem which has confronted the managers of central stations has been the relation between the cost of installation and the return thereon, which must be secured during a very small portion of the hours of the day. This makes the cost of horse power per annum very high when investment charges are considered, and even those most unfamiliar with the problems confronting the central-station managers nevertheless have at least a vague familiarity with the question of the search for a day load. The new and strenuous demand for motor carriages seems to us to furnish the key to the situation, and the small cost in trouble and money which the central station manager need give in encouraging this demand will amount to nothing as compared with the certain return which in many localities can be even now supported by the figures.

It does not seem to me to be an exaggeration to say that the horseless carriage builder now offers the solution of this vexed problem.

OBSERVATIONS ON ST. ELMO'S FIRE.

THE following interesting observations on the silent electric discharge known as "St. Elmo's fire," made at the Brocken Observatory, Germany, are described by Dr. Stade, of that observatory, in the Meteorologische Zeitschrift. His report is abstracted in Gaea (Liepsic, October) from which The Literary Digest translates the following extracts:

"St Elmo's fire, in spite of the systematic observations kept up at the Brocken Observatory since October 1, 1896, has been seen there only twice in that time: on March 29, 1897, and on February 16, 1898, both times in thick fog and sleety snow, which fell the first time in a stiff west wind, the second time in a west northwest wind. Both times the appearance showed itself first about 9 P. M., the time of the regular evening observation. The first time the phenomenon lasted so short a time that no adequate examination was possible; but the second time, owing to its greater intensity and longer duration, its structure and the nature of the electric discharge could be clearly perceived.

"On the evening of February 16 it shone out in intense reddish white flames on the top of the lightning conductor, and also ranged in short rows on the crystals of frost that covered the conductor, as well as on the other neighboring objects both bare and frost covered, for instance guide-posts and the corners of roofs. Flames sprang also from the hair and beards of the observers and from the little crystals of frost that adhered to their garments. The fact that by holding the finger over the point of the lightning conductor the flame can be made to appear from the tip of the finger is a well-known characteristic of the phenomenon, for in many accounts of observations of St. Elmo's fire it is recorded that the flame could be made to spring back and forth from one object to another near by. When the finger was held near the lightning conductor, the light disappeared in an instant, to reappear on the finger, when the latter was at least 2 centimeters [¾ inch] distant. Strangely, it could easily be seen that the luminous appearance, besides the metal lightning conductor, preferred the bare projecting beams to the well-conducting hoar frost.

"The outer structure of the flames, whose origin could be traced by means of an electroscope to a discharge of positive electricity, agreed well in size and shape with the description given by Von Obermayer in 1888. They consisted of an elliptical intensely reddish-white nucleus about 3 millimeters [⅛ inch] long with a continuation, in the direction of the major axis, of a still longer tongue of like color, and on this a brush of fine reddish-white rays, growing whiter toward the end, and spreading outward at an angle of about 90°. On the hair of the beard the whole flame seemed to be only about ¼ centimeter [⅛ inch] long; on the frost particles that clung to the garments of the observers appeared only bright specks of approximately elliptical form, without rays. This form of the phenomenon was not described by Von Obermayer; the violet coloring of the tips of the ray, noted by him, was not observed, and perhaps was overlooked.

"The brushes were very steady and motionless, and so bright that the electroscope could be read without artificial light.

"After ceasing for a considerable time, the phenomenon appeared again about 9:45 P.M. in a slightly different form; now it consisted of a whitish-violet nucleus about 6 or 7 millimeters [¼ inch] long, with a long white branch surmounted by a brush of whitish-violet rays at a maximum angle of 45°; the appearance was very feeble, especially when it was transferred to the finger-tip. When one of the thickly falling sleety snow-flakes passed over the tip of the lightning conductor, it was still weaker, almost disappearing for the moment. This unstable character as well as the different structure and smaller motility, sharply distinguished this form of the phenomenon from that first described. It was the negative variety of the St. Elmo's fire. . . .

"The first variety was due to a discharge of positive electricity from the earth; the latter to that of negative electricity. As is well known, changes from positive to negative electrification and the reverse often occur on the earth's surface in a very brief period.

"In agreement with former observations, there was neither lightning nor thunder on the Brocken on March 29, 1897, nor on February 16, 1898. Also, it is not known whether the clouds that surrounded the mountain from 9 to 10 P. M. on February 16, moving from west-northwest, caused electrical discharges anywhere near by; but, according to newspaper reports, there was considerable thunder during a snowstorm that occurred at Hildesheim, to the northwest of the Brocken, at the same time that the St. Elmo's fire was seen on February 16.

"The crackling noise described by many observers as an unfailing accompaniment of the St. Elmo's fire was noticed only on February 16, and then only on the tip of the electroscope.

"During and after the St. Elmo's fire of March 29 a peculiar shadowless twilight shone in the atmosphere; in spite of the very thick mist and the absence of moonlight, objects a hundred yards away could be distinctly recognized; it seemed as if the observer were within a feebly self-luminous cloud."

SCIENTIFIC WORK OF THE UNITED STATES DEPARTMENT OF AGRICULTURE.*

WEATHER BUREAU.

ARRANGEMENTS have been made to establish stations for making meteorological observations and displaying hurricane signals at Kingston, Santiago de Cuba, Santo Domingo, St. Thomas, Barbados, Dominica, Trinidad, Curaçao, and Barranquilla.

When the West Indian service is fully established twice daily, reports will be received not only from the stations named, but also from Havana, Nassau, Vera Cruz, Tampico, Coatzacoalcos, and Merida. The improved storm warning service will largely benefit the commercial interests throughout the West Indies.

The Central Meteorological and Magnetic Observatory of Mexico has begun the equipment of about thirty stations in the Mexican Republic, with the most approved meteorological instruments, and will establish a meteorological service similar to our own. When completed, an exchange of reports, especially those relating to the approach of West Indian hurricanes and "northers" in the Gulf of Mexico, will be effected.

Aerial observations by means of kites were continued during the year. It was hoped to establish at least twenty stations, but it was found that only sixteen could be completely equipped. It is too early to express an opinion regarding the value of the observations already secured in the aerial work of the bureau.

The importance of the study of meteorology in the United States has been kept in mind, especially in the assignment of observers to duty at points where there are colleges or universities not already provided with instructors in meteorology, and during the past year the courses in meteorology have been strengthened in a large number of high schools and academies.

The bureau has begun the collection of statistics of loss to farm property, including live stock in the fields, by lightning, so as to determine the frequency of lightning stroke and the amount of property destroyed annually by that phenomenon.

* Extracted from the report on the work of the United States Department of Agriculture for the year ending June 30, 1898.

VEGETABLE PHYSIOLOGY AND PATHOLOGY.

The work of this division is carried on with a view of obtaining additional light on the conditions governing the growth and production of cultivated plants, with special reference to diseases, nutrition, and development of new and improved sorts by breeding and selection.

During the year valuable knowledge was obtained relative to increasing the sugar and starch producing power of plants, and the effect of soil foods on their growth and productiveness.

The work of hybridizing the sweet orange with the hardy trifoliate, with a view of obtaining a variety resistent to cold, was pushed on, and about one hundred and fifty hybrids obtained. In addition to this about one thousand hybrids of other citrus plants were obtained. Considerable work was done in crossing pineapples, and as a result two hundred and fifty-nine hybrid seedlings were secured. These produced plants of great vigor, and confirmed the belief that by this means there may be produced fruits which will be larger, of better quality, better shippers, and more resistent to blight. Similar work was carried on with pears and with wheat and other crops.

BIOLOGICAL SURVEY.

With a view to determining the areas best adapted for various crops, the Biological Survey has been engaged for several years in collecting data for mapping the natural life zones of the United States. A detailed study of the distribution of the native animals and plants has been made in the belief that areas inhabited by indigenous species coincide with those most suitable for certain varieties of fruit and cereals and for breeds of domesticated animals. This investigation has now progressed far enough to permit the publication during the past year of a revised map of the life zones of the United States and two reports containing the results of more general interest to farmers and horticulturists.

One of these reports comprised a description of the life zones and crop zones of the United States, with lists of the more important varieties of fruits and grains adapted to each area; the other, an investigation of the geographic distribution of some of the more important cereals.

The Biological Survey is often called upon to determine the value of birds and animals to practical agriculture. A careful study is made of the food of useful and injurious birds and mammals, and thousands of stomachs of birds are examined in the laboratory. Two thousand three hundred and twenty-nine stomachs, mainly of sparrows, swallows, and woodpeckers, were examined during the year. A report has been published on the native cuckoos and shrikes, and reports on flycatchers and native sparrows are in prepacation. Several of the latter birds feed largely on weed seed during the winter, and it is a matter of no little interest to determine how far they can aid the farmer in checking the increase of noxious weeds. The importance of this work is emphasized by the increasing demand made on the department for information and publications on birds, in consequence of the recent widespread popular interest in ornithology.

FORESTRY.

At the end of the fiscal year the creation of the New York State College of Forestry and the election of Mr. B. E. Fernow to the directorship created a vacancy in the position of chief of the division, which Mr. Fernow held for twelve years, and Mr. Gifford Pinchot, of New York, was appointed his successor.

One of the most useful lines of work has been an investigation of the forest conditions of the State of Wisconsin, in co-operation with the State Geological Survey.

The accumulated data of the investigations in timber physics has been worked out in part and yielded some most important results, among which the law that the strength of a beam at the elastic limit is equal to the compression strength of the material, which was established by the tests of the division, will influence the practice in the use of wood for construction most advantageously.

AGROSTOLOGY.

Through the efforts of this division the needs of the several sections of the United States are being determined, and the forage problems which they have to meet are being found. The work leads to a better knowledge of the distribution and value of the native grasses and forage plants, as well as the peculiar conditions of soil and climate best suited to their growth. More than five hundred varieties of grasses and forage plants valued for forage have been grown in the grass garden on the grounds of the department during the past season.

Over 5,000 specimens of American grasses have been identified during the year, and nearly 3,000 sheets of herbarium specimens mounted and added to the National Herbarium. The grass collection now in the department numbers over 30,000 sheets.

SOILS.

Records have been continued of the moisture content of some of the principal soil areas in the country with the electrical method of moisture determination. As the soil is the immediate source of the water supply of plants, this record becomes an essential part of climatology, and it seems probable that this work of the Division of Soils, in connection with the present work of the Weather Bureau and of the Division of Statistics, will develop a distinctively new line of agricultural climatology. This work is closely related to the work of the Weather Bureau, but is supplementary to it. It includes the record of evaporation to which the plant is subjected, the water supply maintained by the soil for supplying the loss due to this evaporation, and the intensity of the actinic and heat radiations which influence the physiological activities of the plant. Numerical values can be given to the evaporation and to the soil moisture conditions, so that it is possible to express numerically the relative conditions of plant growth from day to day so far as these two important factors of evaporation and water supply are concerned. This will add greatly to the practical value of our knowledge of climatology.

Among the most important lines of work which the department can take up for the *tobacco grower* is the study of the diseases in the tobacco bed and the comparatively few diseases in the field, and particularly the study of curing and fermentation. A large amount of research work has been done, particularly in Germany, in the fermentation of tobacco, but very little is yet known of the changes which go on in the process or regarding the specific agents which bring about these changes. So much information and practical benefit have been derived from a study of butter and cheese, in the control of the ferments and bacteria which produce the texture and flavor of the product, that it is very desirable that similar knowledge in the curing and fermentation of tobacco, and similar control of the finished product, should be secured. This work will require very careful study of the changes in the fermentation pile in the different tobacco districts.

If American tobacco growers are to attempt to raise a product equal to that of Cuba and Sumatra, and if this is to be done, not by chance, but through systematic, scientific investigations, then the soils and other conditions of growth must be thoroughly understood, and the fermentation changes carefully worked out in Cuba and Sumatra. It is necessary, therefore, that a soil expert and a bacteriologist extend their work to these foreign countries.

BOTANY.

The Division of Botany is at work to reduce the importations into the United States of the little things that have been costing the Americans $8,000,000 annually. Western States are now growing chicory. In 1896, 16,317,888 pounds were imported, in 1898 only 315,707 pounds of raw chicory were imported. The farmers of Michigan, Nebraska, and other States will now furnish the supply. Ginseng is also a promising plant for cultivation. The Division of Botany will make tests to protect farmers and merchants against foul and fraudulently imported seeds, and test the importations of the Department before distribution.

The distribution of young plants to various parts of the country was continued during the year, reaching a total of nearly 190,000, including bulbs. Among these were olive, fig, and camphor plants and cuttings. Attention is called to the fact that the growing of rubber plants, even in the most favorable localities of Florida, can hardly be commercially successful.

EXPERIMENT STATIONS.

The annual grant of $720,000 for the agricultural experiment stations is supplemented by $400,000 from the States. About four hundred reports and bulletins were issued by the stations in 1897, which were directly distributed to over half a million addresses.

The need and value of scientific researches on behalf of agriculture are now very clearly understood, and the number and importance of institutions organized for this work are constantly increasing in all parts of the world. Nowhere has so comprehensive and efficient a system of experiment stations been established as in the United States. In the scope and amount of their operations, and in the thoroughness with which the useful information they obtain is disseminated among the farmers, the stations are unsurpassed.

The stations are not the only means for the education of the farmer. Agricultural colleges, farmers' institutes, boards of agriculture, and various other agencies have been established to instruct the farmer regarding the present status of agricultural science as applied to his art. It is the business of the experiment stations, on the other hand, to advance knowledge of the facts and principles underlying successful agriculture, and to teach the farmer new truths made known by their investigations. The act of Congress creating the stations clearly defines their functions to be the making and publishing of original investigations. Whenever a station has neglected this, and merely endeavored to educate the farmer, we find a weak station, and whenever a station has earnestly devoted itself to original investigations, we find a strong station. The station may very properly lend its influence to strengthening the influence and work of the educational agencies established for the farmers' benefit, but it fails to fulfill its real mission when it resolves itself into a bureau of information, or devotes a large share of its energies to the compilation of popular treatises on agriculture. It is gratifying to observe that the original investigations at the stations are increasing in number and improving in quality.

The movement for the extension and popularization of agricultural instruction is growing in importance. The short and special courses in the colleges, the farmers' institutes, and the home-reading circles are attracting larger numbers of farmer students. The effort to introduce nature teaching, largely on subjects relating to agriculture, is being actively prosecuted in several States.

The investigations upon the "nutritive value of various articles and commodities used for human food" have been pursued as hitherto, in co-operation with agricultural colleges and experiment stations and other educational institutions. Special investigations with the respiration calorimeter have been made, in which not only the nutritive value of the food consumed but also its relations to the heat and energy evolved by the human body during periods of rest and work have been measured with a completeness and accuracy hitherto unknown. These investigations are not only of very high scientific importance, but have also already given promise of useful practical application. The results of the careful studies of the dietaries of people of different occupations, made in connection with the nutrition investigations, have been widely republished.

It is believed that the nutrition investigations of the Department have already done much to establish a scientific basis for the courses of instruction on the food and nutrition of man, which are rapidly increasing in number and importance throughout the country.

PRACTICAL EXPERIMENTS IN NATURE TEACHING UNDER STATE AUTHORITY.

In New York, the College of Agriculture of Cornell University has a special State grant of 25,000 dollars per annum to be used in aiding the introduction of nature teaching into the common schools and the carrying on of simple agricultural experiments in different parts of the State. The plan followed has been to employ experts in the different sciences to prepare brief leaflets containing lessons on various subjects for the use of teachers in the common schools. These leaflets are distributed to teachers throughout the State, and there has been such a large demand for them from teachers in other States that arrangements have been made to sell them at a nominal price.

The professors and other agents of the university attend meetings of teachers from time to time, to explain the scope of this work and to show the teachers how to carry out simple instruction on nature topics. Many of these leaflets relate directly to agricultural subjects. For example, in one leaflet the teacher is instructed to have the children plant squash seeds, take some of them up at intervals to learn how the seeds germinate, and watch what happens to the little plants as they grow. At another time the children are encouraged to plant little gardens and carefully watch some of the things that grow in them; or they study some insect which preys upon fruit, or make collections of the insects about their homes, or watch them to see whether they are doing things good or bad for the farmer. This movement has rapidly increased in popularity, and the leaflets are used in many city schools as well as in those in the country. Hundreds of simple experiments with fertilizers on potatoes have been carried on in different parts of the State with some of the money above referred to. For carrying on all this work the university has employed its teaching force and a small corps of special agents and clerks.

In Indiana, Purdue University has undertaken a similar work, though its funds have not permitted it to make it very extensive. A number of leaflets have been prepared by different members of the faculty, and have been sent out to teachers throughout the State. In a number of other States nature teaching has been introduced into the common schools, but for the most part in the schools in the larger towns and cities, where there were teachers who had had some training in natural science. As a result of the widespread interest in this subject, teachers' manuals and text-books for instruction in this branch are being prepared.

ANIMAL DISEASES.

The bureau has continued experimentation with antitoxin serum for the prevention and cure of hog cholera. Congress, at its last session, made a grant in aid of this work, which became available at the beginning of the present fiscal year. Buildings were erected at an experiment station, and animals purchased to make the serum in sufficient quantities to conduct extensive research. The results of the previous year have been corroborated. Eighty per cent. of the animals treated were saved, while a like per cent. of the check herds not treated died. This justifies the Department in efforts to supply in future to herdsmen throughout the country such serum as can be made. It is for Congress to determine whether serum shall be given free or a charge be made covering the expense of manufacture, which would be about fifteen cents for each animal.

The study of tuberculosis, with reference to both men and animals, has been continued, and the results so far obtained indicate that experiments already begun in this line should be continued, as there is a prospect of more satisfactory results.

Experiments in dipping cattle to kill the ticks which cause Texas fever were continued, with the gratifying result that a substance has been found which will destroy all the ticks on an animal at a single dipping, and will not injure the animal.

CHEMISTRY.

The Division of Chemistry during the past year has continued its work on the composition and adulteration of foods. An elaborate bulletin, treating of the composition of cereals and all cereal products, represents the results of the principal amount of work in this direction. Another bulletin is devoted to the composition and uses of Indian corn, and this bulletin was prepared especially for presentation at the third International Congress of Applied Chemistry in Vienna, which met in July, 1898.

The Division continued during the year its investigations of the possibilities of producing high-grade sugar beets in various parts of the United States. As a result of the extensive chemical studies conducted, the area suitable to the production of the best beets has been more definitely delineated. A few years more of studies of this kind will mark out in a practical manner the areas where beets of the highest grade can be produced.

ENTOMOLOGY.

General investigations have been carried on in this Division through the year upon insects injurious to garden crops, to shade trees, and to citrus trees and fruit. The general experimental work, with remedies, has comprised especially careful investigations of the availability of hydrocyanic acid gas in the disinfection of seeds in bulk and of plants and nursery material, and further experiments with arsenicals and various oil mixtures in order to determine their effects on plants in dormant condition and in foliage.

A preliminary attempt has been made to introduce from Southern Europe into California an insect which is responsible for the fertilization of the Smyrna figs of commerce. The entomologist visited California in the spring of 1898, and found that conditions were ripe for such an attempted introduction, and an agent in Europe will, during the coming year, endeavor to take the necessary steps to bring about this introduction, which, it is hoped, will result in the production by California of a fig equal to the Smyrna fig.

A successful importation has been made of an important parasite of certain large scale insects.

Other important work carried on under this division during the year has included the sending successfully of beneficial species to foreign governments suffering from outbreaks of the white or fluted scale, the preparation of an account of the work accomplished during the past two years against the San José scale, an investigation of the injurious grasshoppers of the Western States; work upon remedies to be used against the housefly, suggested by the growing belief in the importance of this insect as a carrier of disease; work upon the geographic distribution of injurious insects of the United States, and experimental work in agriculture.—*Nature*.

A JIB-HEADED MAINSAIL SLOOP ICE YACHT.

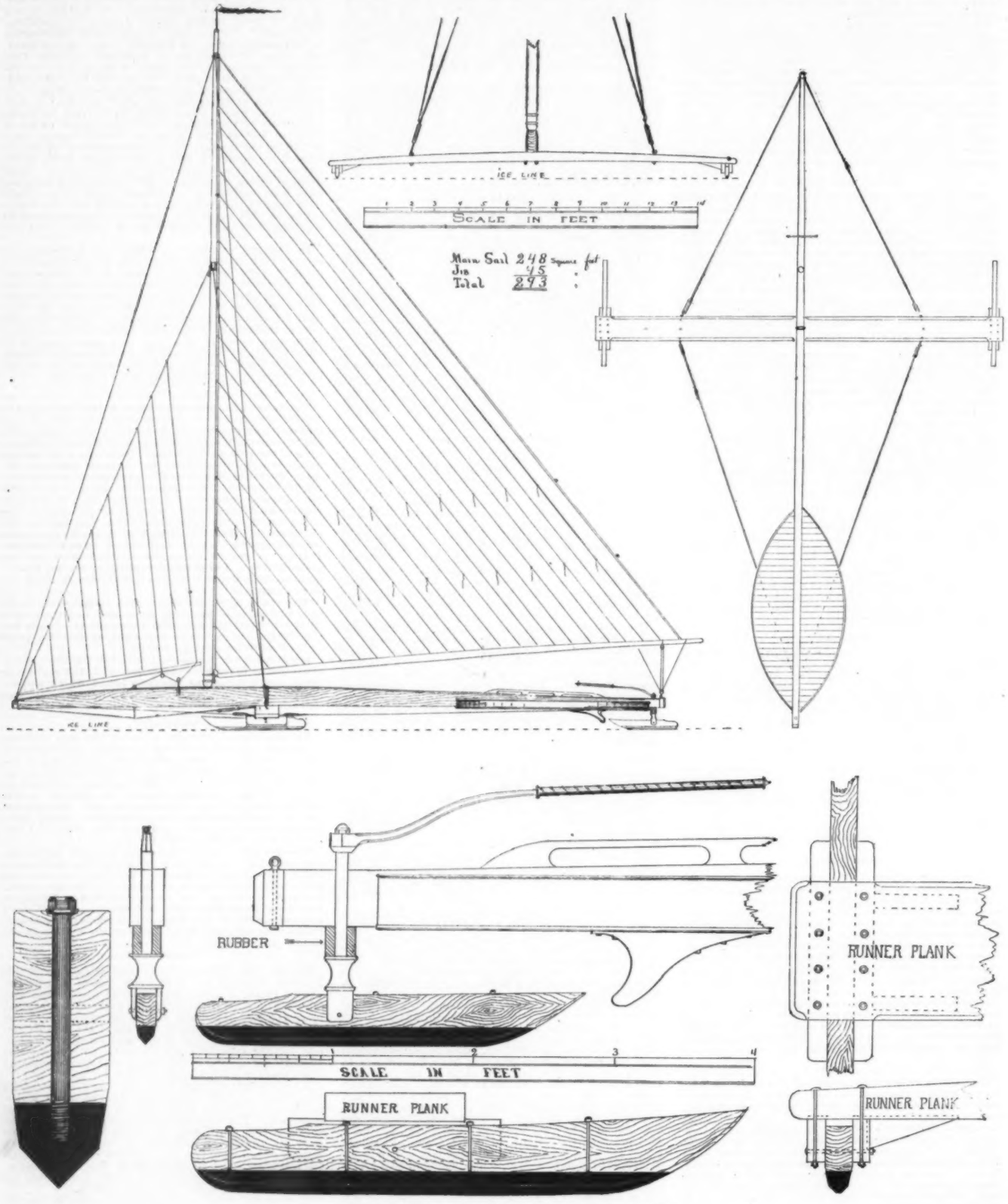
By H. PERCY ASHLEY.

THE prospects are good this winter for an unusually gay season of ice yachting, the king of winter sports. Many new yachts are building in the United States and Canada. The West especially is very enthusiastic over this exciting sport, and there is hardly a lake of any size but what has its fleet of ice yachts.

The latest design for ice yachts is a jib-headed mainsail sloop rig. The advantage of this rig is that extra canvas can be carried, and yet, with a liberal spread of runner plank, there will be no danger of the windward runner rising from the ice. In case of reefing, the sails will retain their correct proportions.

In the accompanying designs a small boat is shown which will prove a low-priced but very speedy ice yacht. The back-bone or center timber is 27½ feet over all by 10¼ inches at highest part, tapering to 4⅛ inches at each end, and has a width of 4 inches. The drawing clearly shows the curve of the back-bone. The runner plank is 17 feet by 12 inches by 4¼ inches, and the fore runners have a cutting span of 16¼ feet. The mast is stepped 8⅛ feet aft from the extreme end of the bow, and the center of the runner plank is 10⅜ feet aft. The cock-pit or steering box is very simple, being light ¾ inch pine, around which is bent a heavy oak strip. The dimensions of the steering box are 8¼ feet by 3⅞ feet. The spars are as follows: mast, 27½ feet; boom, 20½ feet, with jib-boom on foot of jib. The total sail area is 293 square feet divided as follows: mainsail 248 square feet, and jib 45 square feet; total, 293 square feet. The measurements of the sails are, mainsail: hoist, 26 feet; boom, 19⅝ feet; leach, 31 feet. Jib: foot, 7¾ feet; distance on stay, 15⅜ feet; hoist, 12½ feet.

The drawing of the runners, with scale attached, clearly shows their construction and make-up. The material is white oak with soft cast iron shoes. The fore runners (oak) are 4 feet by 4½ inches by 2⅛ inches. The cast iron shoe is 2⅛ inches deep. The rudder is 2⅞ feet by 1¾ (oak) with a 2 inch shoe. Basswood is preferable for the back-bone and runner plank, but a fine grade of clear white pine can be used. The spars are of spruce. A full description of a lateen ice yacht can be found in SCIENTIFIC AMERICAN SUPPLEMENT of February 12, 1898, also a first-class up-to-date sloop ice yacht in SUPPLEMENT of December 10, 1898.



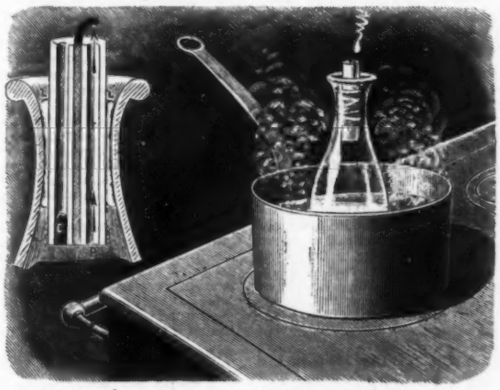
A JIB-HEADED MAINSAIL SLOOP ICE YACHT.

The world's crop of oats for 1899 is 2,710,000,000 bushels, or an increase of over 135,000,000. As in most other cereals, the United States leads, producing 785,000,000 bushels against Russia's 740,000,000 bushels. The Russian output is most phenomenal, for in 1898 it was but 580,000,000 bushels, and in 1897, 560,000,000 bushels. After Russia comes Germany with 296,000,000 bushels, France with 265,000,000, and Austria-Hungary with 182,000,000 bushels.

EXTINGUISHING FLAMES BY EXPANDING AIR.

ALL bodies when subjected to the action of heat expand, gases more than others. How great is the force exerted by an expanding gas, atmospheric air for example, can be excellently demonstrated by a simple experiment described by the Illustrirte Welt.

Part of the apparatus employed is a candle formed with three channels running through its entire length. The lower ends of two of these channels are plugged with wax, *C*; the third channel is closed with a piece of moistened cigarette paper, *P*. The candle after having been thus prepared is inserted in a thin-walled glass bottle. In order that the neck of the bottle may be closed as tightly as possible so as to exclude all air, a piece of linen is wrapped about the candle. The wick of the candle is then bent over the channel, *T*, and ignited; and the bottle is placed in a vessel containing warm water. Under the action of the heat, the



HOW TO EXTINGUISH A FLAME BY EXPANDING AIR.

air immediately expands, blows out the cigarette paper and rushes through the channel thus opened with such force that the flame of the wick is extinguished.

CHINA SILK TRADE.

IT is worth while to remember that, however hopeful European exporters may be of finding in China increasing outlets for their goods, the fundamental condition for a brisk import trade is an increasing export trade, and that lately some very alarming statements have been made respecting one of the most important of China's industries, the production and reeling of silk. The alleged decadence of this industry appears the more serious as similar reports have for some time past been current with regard to another leading Chinese industry, that of tea cultivation and preparation. Mr. Rocher, the Commissioner of Customs for Shanghai, made some statements in his report on the trade of that port during last year, in which he called attention to the inferiority of last year's cocoons in China, the spread of disease among the worms, and the general lowering of the vitality of the breeds. Mr. Rocher has followed up his warning by a letter to the Viceroy—which has been published in The Chinese Gazette—in which he makes some very emphatic statements respecting the extent and reality of the evil. Nine years ago, when the question of Chinese silk culture was taken up by a predecessor of Mr. Rocher, many of the silk-growing districts were still free from disease, but in consequence of the neglect of the warning then given, the disease has since made "enormous progress," and China seems to be threatened with that general extermination of the silkworm which had almost been completed in France and Italy when Pasteur began his memorable researches into its causes and succeeded in arresting its march and reconstituting the industry in both countries. It may now be said, Mr. Rocher urges, that almost all the silkworms in China are diseased, and the effect on the silk-producing capacity of the worm is very marked. Formerly one picul of silk was obtained from three piculs of cocoons, but last year five piculs of cocoons, on the average, only yielded one picul of silk, and this year six and a half piculs of cocoons have been consumed in obtaining the same result. Owing to bad and short crops, the cocoons have been dear as well as poor, and it is in consequence of this fact that so many of the steam filatures, or silk spinning mills, in the Shanghai district have been closed, the total number of these establishments at work having been reduced from 25 last year to 11 this year. It is now stated that not a single district in China where silk culture is carried on remains quite free from the disease. This condition of affairs implies a large loss of revenue for both the central and provincial governments, and the Kiangsu and Chekiang provinces, hitherto made rich by the silk industry, are likely to be impoverished more and more every year if the ravages of the disease are not arrested.

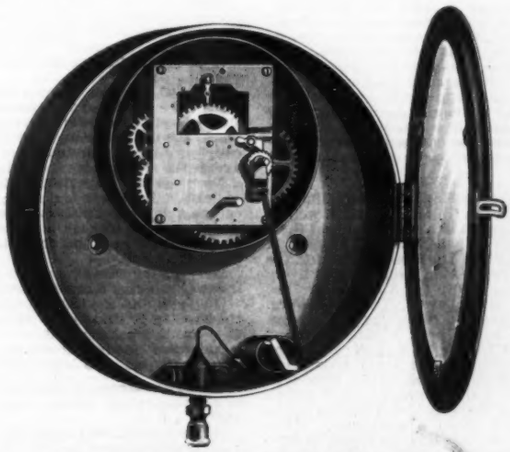
Under these circumstances, Mr. Rocher, who two years ago made suggestions to the Viceroy for checking the decay of the tea trade of China, appears to have succeeded in awakening the Viceroy's interest in the silk question, and in obtaining official financial support for organized methods of re-establishing healthy breeds of silkworms throughout China. His plan consists in the adoption of the methods recommended by Pasteur—the selection of healthy moths by the aid of the microscope for the production of healthy eggs. Two "nurseries" are to be established in the provinces of Kiangsu and Chekiang respectively, each of these stations to be under the charge of a foreign assistant, and the two stations to be under the control of a foreign director. Mr. Rocher estimates that in three years' time a sufficient number of pupils will have been trained and native breeders educated to enable the growers to go on without further external assistance. Expensive buildings, he has pointed out, are not necessary for the experimental stations. The necessary expenditure, he estimates, will be fully provided for by a payment of 6,000 taels per annum during the three years by each of the two provinces mentioned. It is stated that provision has already been made by the Viceroy for the payment of these subventions, which, in comparison with the enormous importance of the work to be done, may well be regarded as extremely moderate. No little importance may also be attached to the educational influence of this latest attempt to introduce Western science into China. The proposed "nurseries" may prove not merely instrumental in regenerating the Chinese silk industry, but influential aids in the regeneration of the Chinese empire itself. Hitherto, according to The North China Herald, the greatest obstacle in the way of all attempts to impress the Chinese silk growers with the suicidal nature of their past neglect has been the competition among the foreign buyers of cocoons. So long as the breeder can sell his cocoons at a good price he cares nothing about their quality, and as the weight of silk in the cocoons has decreased he has tried to keep up the quantity by hatching more worms, with the result that the price of mulberry leaves has been raised, and a very large proportion of the worms are "half starved and sickly creatures, unable to produce either quantity or quality." The filatures have had to pay higher prices for the cocoons, and the outlay in wages per picul of silk obtained has also been increased, as more labor in proportion to the result is required for the manipulation of cocoons of inferior than for those of good quality. Another difficulty is apparently the unwillingness of the Chinese to pay for experiments with a view to a future reward. It is for this reason that Mr. Rocher has refrained from endeavors to obtain financial support for his undertaking from native merchants and silk growers. "The trade," he remarks in his letter to the Viceroy, "is sufficiently taxed already, and further taxation would increase the harm;" moreover, it would make those interested suspicious and "provoke their ill-will instead of their co-operation." It is by a demonstration of the practical benefits to be ultimately reaped that Mr. Rocher hopes to convert the native growers and merchants.—The Textile Recorder.

AN IMPROVED PRESSURE-RECORDING GAGE.

THE pressure gage herewith illustrated, invented by W. H. Bristol and made by the Bristol Company, of Waterbury, Conn., is a very compact and efficient instrument. The pen arm is directly attached to the free end of a tube of flattened cross section, which is bent into a helical form, located in the bottom of the circle.

The tendency of pressure applied is to straighten or uncoil the helical tube, which causes the pen arm to move over the range of the chart without the necessity of any intervening multiplying devices. The clock mechanism for rotating the chart disk is in the upper part of the case.

Its operation is simple and effective. These gages are said to give excellent satisfaction wherever tried.



THE BRISTOL PRESSURE-RECORDING GAGE.

TECHNICAL EDUCATION IN GERMANY.

GERMAN tradesmen and manufacturers are alive to the importance of increasing the efficiency of their mechanics and artisans, and improving the quality of their goods. They are resolved that "Made in Germany" shall no longer pass as a term of opprobrium, but be a synonym of excellent materials and good workmanship.

Yesterday, there took place in this city a meeting likely to exercise a very important influence in this direction. It was in the nature of a conference, under governmental sanction and direction, to discuss German trade and manufacturing interests and to devise plans for their extension and improvement. It was held at the instance of the Prussian Minister of Trade and Commerce, and was presided over by the Oberregierungs President of the province of Hanover, Count Stollberg. Representatives of the government from Berlin, the highest officials of the Hanoverian provincial and municipal administrations, leading manufacturers and business men, delegates from the chamber of commerce, the manual training and artistic trade schools, and from the workingmen's trades unions, attended and took part in the deliberations.

As a result of the conference, it was unanimously resolved:

1. To establish at once in the city of Hanover advanced lecture courses, in which artisans and apprentices in all trades shall have an opportunity to complete their mechanical education and be instructed by experts how to install and manage a model workshop and work and use machines and tools to the greatest advantage. Instruction will also be given in bookkeeping, the making and rendering of accounts, the making of estimates of the cost of work and materials, how to conduct business correspondence, drawing, and other practical branches.

2. The oversight and control of the said lecture courses shall be under the direction of a commission composed of representatives from the imperial, provincial, and municipal administrations, the chamber of commerce, the manual and art schools, and from the trades unions.

3. The first courses of lectures will be to cabinet makers, locksmiths, shoe makers, and tailors. Those to other trades will follow.

4. A fee for tuition will be exacted from mechanics able to pay, but those unable to pay will be instructed free. Funds for the payment of the tuition of the poor will be provided by the Hanover provincial and municipal governments.

5. Only mechanics and apprentices will be admitted to the classes whose theoretical and practical knowledge is such as to give promise of success as students. The commission has power in all cases to decide as to qualification of applicants for admission.

6. Teachers are to be selected by the commission and confirmed by the Minister of Trade and Commerce.

7. The cost of the establishment and maintenance of the lectures is to be supplied by the general government and that of the province and city of Hanover, together with the trades unions, the chamber of commerce, and others interested therein.

8. It is further intended that great care shall be used in teaching apprentices how to obtain the most practical advantages from the knowledge acquired by them in the classes. To this end, the creation of workingmen's co-operative societies is to be urged.

9. A permanent exposition of all power machines and tools used in the small trades is to be established in the Gewerbe-Halle (Industrial Hall) at Hanover. The machines exhibited there are to be worked by competent mechanics, who, on request, will exhibit their uses and management to all inquirers.

In connection with the machine exhibition, there will also be established an exposition of sample products, in process of manufacture as well as finished.

10. In order to enable small manufacturers and tradesmen to purchase their raw materials at wholesale prices and to facilitate the sale of their products, the formation of co-operative stores at designated places is to be encouraged.

I am informed that the establishment of these courses of lectures to mechanics is the initial move in a general plan to be inaugurated in all the main labor centers of Germany, dependent upon the success of this experiment.

The expositions of tools and machinery proposed to be established in connection with the lecture courses, in my opinion, offer an excellent opportunity to American manufacturers to make exhibits.

In the boot and shoe trade, from the making of the lasts to the finished product, American machines are the favorites. Perhaps the same result might be reached

with the other small trades, if masters and workmen in Germany had an ocular demonstration of the superiority of our tools and machines over those they have been using. W. K. ANDERSON, Consul.

Hanover, December 9, 1899.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

American Cotton Goods in West Africa.—Few of our manufacturers of cotton goods think of the possibility of introducing their products into the vast stretch of West Africa; yet there is a promising opening here for them, says Consul J. T. Williams, of Sierra Leone. With the enlargement of our plants and the improvement of machinery for the manufacture of cotton goods, there should also be increased effort to secure a trade footing in the tropical countries, as more cotton fabrics are used as clothing here than any other kind of goods. Tropical markets, such as this coast presents, will be consumers for generations to come. European firms show much activity in seeking to secure and control this trade. Their policy is not so much to make enormous profits now as to gain trade advantages for the future.

Africa, like China, is the land of the "teeming millions," and as the natives are brought into contact with Europeans, they are rapidly acquiring the habits and customs of civilization and are becoming large consumers of dry goods.

Great quantities of prints, sheetings, shirtings, etc., are daily transported to the interior towns and villages by native carriers, by canoes and sailing craft of every kind. These goods are largely imported from England, France and Germany, whose manufacturers cater to native fancy and taste in certain lines of goods. In addition, the representatives of these firms have the advantage of long acquaintance with the African and have made local business arrangements that please the natives, employing them in the capacity of clerks, bookkeepers, etc., and thus keeping their goods constantly before the mass of native dealers.

The African as a rule is proud; he despises rags and places a premium upon good material. The native merchants, besides being shrewd traders, are excellent judges of dry goods—especially of the durability of fabrics of any kind. Being familiar with climatic conditions, they know what suits their trade, and that only will they buy. The low price of an article, if it is not suited to their taste, is no inducement to buy. It is simply what is wanted that sells. Nothing but the best goods for the cheapest money value should be sent here. Coarse cotton fabrics would not sell well; checks, ginghams, unbleached domestics, etc., are considered too common; on the other hand, satins, prints, muslins, madras, karkis, sheetings and shirtings, and various other classes of cotton goods, would be popular if of good finish and attractive colors—any modification of blue and white or blue and black in prints or satins would please.

With the growth of American trade in competition with that of other nations, our manufacturers should pay more attention to making goods for export according to the requirements of the trade sought. Attention given to these details, together with our extensive facilities for superior work, will enable us to win.

The traditions of the African race should not be ignored in manufacturing for this market; for example, certain animals, trees, plants, vines, and even seashells are held in great respect by the natives, having been worshiped by their ancestors. The present generation does not forget these traditions, though many are educated and enjoy the advantages of civilization.

It is by observing these points that the European exporters have gained such footing in African trade. No doubt, in many instances their goods are inferior to our own in durability—starch taking the place of body—yet they sell because African and not European ideas are respected in the design and manufacture of the goods.

Credit would not be a great inducement except to European houses, as the terms of trade here are generally cash. American goods of all classes would have a better show in this market if there were direct communication between the United States and this coast.

There is now a spirit of keen mercantile rivalry among the nations seeking this trade, but there is encouragement for American dealers to compete, if they will make the necessary efforts along the lines suggested. There are no discriminating tariffs, no restrictive legislation with which to contend. Aside from the 10 per cent. ad valorem duty, this is practically an open field, and with more energy on the part of our exporters of cotton goods, their products can find a good market in West Africa.

American Racing Horses in Russia.—A false impression has been created in the United States, as well as in Europe, by the publication of a statement that there is discontent and dismay among Russian owners of trotters who have imported American horses for the purpose of improving the Russian breed, which every one knows cannot compare with the American trotter, says Consul-General W. R. Hollaway, of St. Petersburg. It is said that after limiting the winnings of American horses, they permitted horses bred in Russia, crossed with American animals, to race for a time; but when they proved their superiority, the same restrictions were imposed on the cross-breed as on the pure-bred American trotter. This, I am informed by well-known American horsemen long connected with leading racing stables in Russia, is too broad a statement. While American horses which outclass Russian horses as trotters have not been permitted to trot in all classes for some years, and for that reason are unable to win much money in Russia, American horses cross-bred with Russian were permitted to start in all but three races that were given in Russia during the past season, viz.: The "Orloffsky," 3,000 rubles; the "Grand Duke's Prize," 10,000 rubles; and the "Emperor's Prize," 25,000 rubles.

At the summer meeting in Moscow, there were 341,500 rubles hung up in prizes, and half-bred horses were permitted to start in all but the three races named above, leaving 303,000 rubles in the purses for which the half-bred horses competed.

There are summer and winter races in Moscow and fall and winter races in St. Petersburg, where 866,000 rubles are offered in prizes annually, and the half-bred horses compete for 747,000 rubles, all but 113,000 rubles of the entire sum.

A few years ago, American horses could start in all races in Russia, but they were so much faster than the Russian horses that they were barred from the big races in order to protect their own interest; but, as a majority of Russian horsemen now own American horses, and more are constantly being bought, there is a growing sentiment in favor of their being permitted to start in all races except those intended exclusively for Russian horses. At one time it was noted with satisfaction that American horses had been purchased for the Russian imperial studs, but recently, every horse having American blood has been removed from these studs. Disinterested persons declare this to be shortsighted policy, and say the Americans do not care what nationality a horse is, provided he is fast; and notwithstanding American horses are the best trotters in the world, there will be a big demand in the United States in the near future for Russian mares, because after interbreeding the different families for so many years, Americans will be glad to get an outcross with trotting blood and muscle.

The breed of Russian horses generally accepted as typical is the "Orloff," founded by Count Orloff-Chemenski at the end of the last century, being a cross between the Arabian stallion Smetanka and his descendants with German, French, Belgian, and Dutch, but principally English mares. The Orloff is not only the light-harness horse of Russia, but almost the only carriage animal in use. While there is no great uniformity in size and form, the best studs are 16 hands high and weigh 1,100 pounds, with heavy manes, bushy tails that reach within a few inches of the ground, and iron limbs that show great muscular development. They are driven at a furious rate, even through the principal streets of St. Petersburg, there being no limit to speed in the city limits, the center of the streets, next to the street car tracks, being reserved for the fast driving. During the winter months, single, double, and three-horse abreast (Troikás) sleighs dash along the streets at three and a half and four minute gait. The color of the horses is black and gray, the latter being the purest.

Next to the Orloff comes the "Bitug," which is a draft horse about 15 hands high, weighing 1,000 pounds, very strong and quick, well formed, beautifully developed, enormous muscle power, with heads that resemble the Arab, fine ears, and large, full eyes, of different colors.

Among the more prominent breeders who have spent large sums in importing American stallions and mares for breeding purposes is Count Vorontsoff, who, until quite recently, was the head of the Imperial Court, Prince George of Leuchtenberg, Prince Serge Golitzine, S. M. Konchin, Nicolas Konoplin, G. G. Elissieff, and Mr. Teleguin, the latter being the owner of Baron Rodgers (2:09¾). Among the best-known American horses now owned in Russia are Victoneere, Baron Rodgers, Beyruth, Captain Wallbridge, Sam Malo, Quarter Stretch, Quarter Cousin, Nominee, Nominator, Harlow, Flush, Crathmore, Dempsey, and Alvin. Baron Rodgers holds the world's record (9:42) in 4-mile races by fifteen seconds. He won between 14,000 and 15,000 rubles during the present season.

American horses soon become acclimated in Russia, and after the first year stand the climate as well as native animals.

No horse is barred from any race (except the three specially mentioned above) on account of his speed, but fast horses are handicapped by being required to pull more weight and starting a few yards farther back. In trotting races at St. Petersburg, but two horses start in a heat from designated places at opposite sides of the track, at the sound of an electric bell, which prevents jockeying for position. The horses follow each other twice or three times around the track, the distance being either two or three miles. No matter how many entries there are in a single race, but two horses are permitted on the track at the same time, and the one making the best time wins the race. In Moscow, the races are managed on the American plan.

Races for the purpose of testing the endurance of horses are frequent, where horses are driven from 25 to 50 miles, then finish the last 1 or 2 miles at the limit of their speed. The horse finishing in the best condition and showing the greatest speed at the close is the winner.

Some of the race courses are divided into separate tracks 10 feet wide and separated from each other by a strip of sod 2 feet wide, giving each horse a separate track, the difference in the length making the handicapping distance for horses of various speeds, which avoids the struggle for the pole.

No "kicking" is permitted from drivers at the close of heats. Each heat is a race; at the conclusion, men carrying big blackboards showing the number, name, and time made by each horse pass in front of the grand stand and through the grounds, in order that all may know the result.

During the winter, race courses are flooded each night and horses trot on 3 inches of ice.

Only stallions are used in cities, mares being kept in the country or shipped to Germany or Austria, where they are in great demand.

American pneumatic sulkies, harness, boots, gaiting appliances, etc., are in general use here.

Italian Showrooms in Port Said.—J. F. Monaghan, vice and acting consul, writes from Chemnitz, October 18, 1899:

German technical papers are calling the attention of local manufacturers to the efforts which Italy is making in the East to procure a market for her goods. She has established a display house at Port Said, wherein she shows to the Eastern world the cotton products of the looms of Lombardy, the porcelain and glassware of Milan, the silk goods of Como, etc. This enterprise was established but two months ago and has been a complete success in every respect. The manager, a man well posted, has his living apartments free, with an allowance of £20 ($97.33) a month, and receives 50 per cent. of the net earnings. Orders worth 40,000 francs ($7,720) have already been taken. This plan has been suggested to our export associations by a number of United States consuls.

Famine Prospects in India.—From special reports recently received by the government of India, the situation may be summarized thus, says Consul W. T. Fee, at Bombay:

In the northwest provinces it is calculated that the autumn harvest will be about two-thirds of the average, and on the whole the provinces are prosperous and should need little relief, as, in spite of the early cessation of the winter rains, the sowings are generally satisfactory. In Bengal and Burma the rice crops are quite up to the average, and should be able to supply the distressed areas. In the central provinces, unless rain falls by the middle of the present month, severe and widespread distress is inevitable; and extensive relief is also likely to be needed in the Punjab, especially in the Delhi division and elsewhere, as the crops have failed badly, and satisfactory cold-weather sowing is not probable. In Madras the prospects are good, and if the northeast monsoon proves normal, relief should be unnecessary. A good deal of assistance will, however, be required in the northern districts of Bombay. Western India seems to suffer the most. The rains of the monsoon having largely failed—in some districts almost entirely and in others to the extent of 50 per cent. or more—a failure of crops and a rise in price of fodder, grain, and food supplies have been caused.

Many distressed natives from the up-country famine districts are now flocking to the cities, hoping to find employment to save themselves from want and hunger. Luckily, the recent good rain has much benefited the Deccan. Roughly estimated, it is now calculated that a crore or a crore and a half (about $5,000,000) will be needed in the provinces for relief to the end of March, though much still depends on the rains of October and November. About half a crore ($2,000,000) will be needed for the Rajputana states, and it is quite possible that the government of India will arrange to advance sums to the states for famine relief. Several railway projects are now being made available for famine labor, especially in Rajputana. It is satisfactory to know that both the imperial and local governments are on the alert, and that all preparations in connection with the probable severe distress are arranged well in advance, while the experience bought during the last famine is being fully utilized.

American Beef in Germany.—Consul Hughes, of Coburg, October 18, 1899, says:

I would call attention to the opening for American fresh beef in this consular district, in spite of the regulations against its importation. If some of the large Chicago concerns would establish proper agencies—like those in any of the smaller towns of the United States—and use them as feeders for the surrounding villages, the business would, without doubt, pay from almost the start. But the same amount of push is necessary in Germany as at home to make anything a success. I have repeatedly shown persons who have written to this consulate for information how they could do a large and paying business in provisions, but they all want to send their goods c. o. d. This cannot be done. German merchants wish to see the article they are buying and also to have three months' credit. The local trader is honest, but he must have time or he cannot do business.

The poorer people in Thuringia live almost exclusively on potatoes, black bread, and beer. We take their dolls and china; they want our beef; why not let them have it?

A New Rubber Plant.—Consul Atwell, of Roubaix, on October 20, 1899, says:

During last week's session of the Academy of Science, papers were read by Messrs. J. Dybowski and G. Frou, on a gutta-percha producing plant, a native of Northern China, which is cultivated in the colonial garden, Paris.

Gutta-percha has been produced almost exclusively up to the present by trees growing in the Dutch East Indies, and attempts to acclimate these trees in the French colonies have not been very successful. The rubber trees of Java require conditions that render their culture impossible in all but a few of the colonies.

The discovery of a gutta-percha producer that may be easily acclimated is thus a matter of great importance.

The advantage of ready growth in a moderate climate is claimed for the plant reported to the academy. It is known as the Eucomia illinoides, and the fruit is said to contain 27·34 per cent. of gutta-percha of excellent quality.

Germany's Meat Imports.—Vice Consul-General Hanauer writes from Frankfort, September 16, 1899:

Germany imported during 1897, 47,986 tons of meat, valued at 39,900,000 marks ($9,496,200); in 1898, 83,597 tons, costing 72,500,000 marks ($17,255,000). Of this amount, the United States furnished 47,243 tons, valued at 39,700,000 marks ($9,448,600). Denmark sent 11,243 tons; Holland, 17,969 tons. The meat imported from the United States consisted mainly of fresh pork. Since 1894, Germany's meat imports from the United States have increased three and a half fold. Our manufacturers should give more attention to the export of smoked sausages. I see no reason why our country should not take the lead as a sausage exporter. There is no doubt that large contracts could be obtained from foreign governments for army uses, if a low price for sausages could be quoted.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

No. 606. December 18.—American Shoe Exports—Hosiery, Handkerchiefs, and Shawls in Paraguay—Cocoa in Paraguay.

No. 607. December 19.—Sisal Grass in Mexico—Inquiry for Wisconsin Tobacco in Belgium—*Steel and Iron Rails Wanted in Australia.

No. 608. December 20.—*Trade and Industry in Costa Rica.—Russia's Financial Statement—Trade in South Africa.

No. 609. December 21.—*American Goods in New South Wales—Practice of Dentistry in Belgium—Shoes in Sweden—Change in Venezuela Tariff.

No. 610. December 22.—Banking, Brokerage, and Credits in France—Scarcity of Bread in Persia—Government Beef Monopoly in Colombia.

No. 611. December 23.—Commercial Conditions in South Africa—Dairy Exposition at St. Petersburg—Regulations of Belgian Fish Trade.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

TRADE NOTES AND RECEIPTS.

The Japanese Art of Lacquering.—The great durability of the Japanese lacquered work is mainly owing to the most painstaking execution of all the necessary operations, the materials used being, of course, also of importance. The process, in short, is as follows: First of all it is necessary that the lacquer be applied only in exceedingly thin layers, whereby it is rendered very pliant and a cracking and peeling of the coatings is prevented. After each operation the articles are subjected to a long-continued drying. To this is chiefly due the great resistiveness of the lacquering. Moreover, the removal of water from the materials used in a lacquer is an important process. Finer objects which are to receive a high luster and transparency are scraped after applying the lacquer and subjected to regular polishing. The wood to be worked is chosen according to the kind of articles to be produced, and is also specially treated before the working. The total number of treatments the article received before it is varnished in color amounts to about thirty. To this must be added the fact that the various manipulations are done by workmen who are especially skilled in that particular branch, so that one can never perform the whole job alone.

These are, in a few words, the principal features of Japanese lacquering. In imitating the work one has to also adhere to the condition that everything must be done neatly and not hastily, and the result will be a satisfactory one. The following is a receipt for an excellent imitation of Japanese varnish. Take 4 ounces of oil of turpentine and 3 ounces of oil of lavender, free it from the water contained therein by adding some calcined potassium chloride, and carefully pour off the oil, and then mingle it with ½ drachm of camphor and 1 ounce of copal. Place the bottle for 24 hours in hot ashes, shake now and then, and finally filter through a cloth. The filtrate is again allowed to stand for 24 hours, after which time the clear liquid above the deposit is poured off. The second deposit may be used mixed with some color—for black so-called gas black is most suitable—for a primary body coat, while the former is worthless for lacquering purposes.—Allgem. Oester. Chemiker und Techniker Zeitung.

Electro-Plating Non-Conductors.—If it is desired to produce an electro-deposit upon a body, this may be accomplished in various ways. Either the deposit is to be removed from the ground, generally a mold, and to be used as an impression, or else it is intended to adhere. In the latter category falls the coloring of metals, such as gilding, silvering, nickeling, etc., but also the production of metallic films on non-metallic bodies to embellish their appearance or to protect them from injury.

In order to avoid the conditions resulting from a slow formation of a deposit upon a non-conductor, it will be necessary to improve the conductivity. Let us see how this is best accomplished.

It will be found that all efforts are in vain if one attempts to produce by chemical operations a surface constituting a coherent metallic film like tin foil, a result which would, of course, be very desirable. Hence, there only remain the two ordinary methods to render the model conductive by graphite or by means of silver solution. There are various varieties of graphite which do not conduct equally well, besides, they are more or less finely pulverizable. The application on the model, or perhaps the mold, is accomplished by brushing or painting, repeating the process so as to put on as much graphite as possible. Reflection will show, however, that by the repetition the conductivity is not much improved, since the graphite which had been applied by the first operation is taken off again and only new particles can take its place. A deposit of the particles on top of one another cannot be attained thereby, besides, this would be useless, since particles not firmly adhering would be washed off on entering the bath. All that can be done is to render the ground, the wax composition, or the porous bodies previously saturated with it, more adhesive by the addition of fat, so that they hold the powder well. The deposit will also be finished quicker if as many conducting wires as possible are stuck into the metal, so as to provide many places of formation for it. That this is tedious and risky is obvious, especially since the wires, as far as they reach into the bath, must be insulated to prevent all unnecessary deposit. Experiments with graphite will furnish the conviction that with its aid such fine, quickly forming and uniform deposits are not certain as allow the fine details of the lower ground to show through the back, having there almost the appearance of the impression from a mold.

Now let us regard the method of producing conductivity by silver solution.

A solution of silver nitrate—lunar caustic, lapis infernalis—in alcohol is used, immersing the object therein or painting it with this. Next it is placed in phosphorous vapor or in hydrogen sulphide, whereby it becomes covered with argentic phosphide in the former case or with argentic sulphide in the latter. Both argentic compounds conduct electricity, but argentic sulphide is preferable because it adheres better to the body on which it is precipitated than the former, and, besides, does not dissolve and come off again like argentic phosphide in the subsequent repetition of the process with silver solution to be made neutral. The silver solution is made neutral by spirit of sal-ammoniac to produce a better division and a better adhesion to the greasy surface, but also to obtain prompter transformation of the silver oxide into silver sulphide, since hydrogen sulphide acts more readily upon neutral than upon acid compounds.

When the model has been rendered conductive in this manner, the deposit takes place only a little quicker than in graphiting, so that not much is gained. An improvement is obtained, however, if the process of producing conductivity is repeated, because the new silver particles will adhere firmly, filling out all interstices, and improving any defective places. Though the ideal, i. e., a metallic film, is not attained, yet the precipitate is caused to spread much quicker in proportion to the number of times the object has been rendered conductive, so that an operation can be finished in a few hours which would otherwise require days and perhaps weeks.—Electro-technischer Anzeiger.

SELECTED FORMULÆ.

Ink for Shading Pen.—The essential feature in the ink for use with a shading pen is simply the addition of a sufficient quantity of acacia or other mucilaginous substance to impart a proper degree of consistency to the ink. A mixture of two parts of mucilage of acacia with eight of ink gives about the required consistency. The following formulas will probably be found useful:

1.	Water-soluble nigrosine	1 part.
	Water	9 "
	Mucilage acacia	1 "
2.	Paris violet	2 parts.
	Water	6 "
	Mucilage acacia	2 "
3.	Methyl violet	1 part.
	Distilled water	7 "
	Mucilage acacia	2 "
4.	Bordeaux red	3 parts.
	Alcohol	2 "
	Water	20 "
	Mucilage acacia	2 "
5.	Rosaniline acetate	2 parts.
	Alcohol	1 "
	Water	10 "
	Mucilage acacia	2 "

Depilatory Cream.—The depilatory cream largely used in New York hospitals for the removal of hair from the skin previous to operations:

Barium sulphide	3 parts.
Starch	1 "
Water, sufficient quantity.	

The mixed powders are to be made into a paste with water, and applied in a moderately thick layer to the parts to be denuded of hair, the excess of the latter having been previously trimmed off with a pair of scissors. From time to time a small part of the surface should be examined, and when it is seen that the hair can be removed, the mass should be washed off. The barium sulphide should be quite fresh. It can be prepared by making barium sulphate and its own weight of charcoal into a paste with linseed oil, rolling the paste into the shape of a sausage, and placing it upon a bright fire to incinerate. When it has ceased to burn, and is a white hot mass, remove from the fire, cool and powder.—American Druggist.

Preservation of Organic Substances.—A new process for preserving animal or vegetable substances in a solid or liquid state, patented by Herr F. W. H. Graeff, of Berlin, consists in exhausting the air from the receptacle that contains them and then impregnating them with an inert gas, such as hydrogen, nitrogen or carbonic acid, at any pressure that may be desired, and finally inclosing them in hermetical receptacles. The process is applicable to the preservation of food of all kinds, and is capable of rendering great services in the industries. It may be employed, for example, for the preservation of butchers' meat, game, fish, confectionery, skins, zoological and botanical preparations, fruits, flowers, vegetables, etc. It may be employed likewise in the preparation of gaseous beverages containing carbonic acid, and especially in the treatment of cream, butter or whey in a fresh state, pasteurized or sterilized. The cream, milk, whey or other liquids are restored to their former state by eliminating the carbonic acid through heating or boiling.

Toning and Fixing Bath Combined.—Burton states that during a period of twelve years in Japan he has used Aristo paper; and not a single copy has become yellow or bleached. He does not wash the print before toning, and uses the bath once only. The bath contains no lead, but is rich in gold, and therefore dear. The following formula gives sufficient solution for a sheet of paper 45 × 55 cm.: Sodium thiosulphate, 60; borax, 5; gold chloride, 0·15; water, 250; calcium carbonate, 2 grm. The carbonate remains undissolved and prevents the bath from becoming acid; filtering is unnecessary. In about ten minutes the copies have a beautiful brown tone, when they must be well washed. —Brit. Journ. of Photography.

Platinum Toning of Aristo and Celloidin Paper.—Gilson advocates the use of the following method for toning Aristo paper: Solution A. Chrome alum, 10; sodium chloride, 40; water, 1,000. For toning, take Solution A, 50; potassium platinous chloride, 1; water, 950. A reddish brown to black tone is obtained; the print is immersed without washing, and if a number of prints are toned at one time, they must be kept in motion. When the desired tone is obtained, the print is immersed in a bath of water containing a little ammonia or soda, and the fixing bath to which the print is brought should also have a trace of alkali added. It is advisable to heat the platinum bath to about 20° C. —Amateur. Photograph.

To Remove Putty, Grease, etc., from Plate Glass.—To remove all kinds of greasy materials from glass, and to leave the latter bright and clean, use a paste made of benzin and burnt magnesia of such consistence that when the mass is pressed between the fingers a drop of benzin will exude. With this mixture, and a wad of cotton, go over the entire surface of the glass, rubbing it well. One rubbing is usually sufficient. After drying, any of the substance left in the corners, etc., is easily removed by brushing with a suitable brush. The same preparation is elegant for cleaning mirrors. Another use it may be put to is the removal of grease stains from books, papers, etc.—National Druggist.

Incombustible Wood.—A patent has been taken out by Mr. E. M. Fox, of Westminster, England, for rendering wood pulp and sawdust incombustible by chemical treatment. The pulp is introduced into a boiler containing a hot solution of sulphate and phosphate of ammonia and provided with a stirring and mixing apparatus, as well as with an arrangement for regulating the temperature. After treatment, the pulp is taken out and compressed in order to free it from its humidity. When dry, it may be used for the manufacture of paper or for analogous purposes. Sawdust treated in the same manner may be used for packing goods, for deadening walls, and as a jacketing for steam pipes.

UNITED STATES COTTON FABRICS IN SOUTH AMERICA.

IN looking over the Venezuelan market, I find that very few cotton goods come from the United States. With the exception of a few cheap prints and heavy unbleached duck goods and sailcloths, no American goods can be found in the stores of this country. I inquired into the reason for this and find that very little effort is made by our manufacturers to introduce their products here, and I suppose that the same might be said of the greater part of South America.

Overproduction is the general cry of the cotton manufacturers at home, with the attendant shutting down of factories and the reduction of wages. Here we have a continent with over 150,000,000 people, who, by reason of the climate, are the natural consumers of very large quantities of manufactured cottons of all kinds; and these goods are mainly bought from Germany, England and France.

During my visit to the United States recently, I questioned a manufacturer as to why his goods were not represented in this market, and in answer was told that he would like very much to increase his business in this direction, but he was afraid of doing business with these countries on credit. He also said that his company had an agreement with a large jobbing house not to do any direct export business.

As to the first reason, I will say that there are houses in this business here and in other adjoining countries which are just as reliable as any United States house; and, as far as credit is concerned, very little business is done in the United States where the "dating ahead" of bills is not the rule rather than the exception. I firmly believe that business can be done here just as safely, if properly handled, as in the United States, and that certain grades of goods for which there is now no market at home can be sold here.

As to the jobber or middleman, I find that the wholesale merchant here is averse to dealing with him. He would rather buy direct from the manufacturer and thereby save commissions. The jobber does not care whose goods he sells, nor where they are sold, so long as he makes his profit; consequently, his efforts are directed toward selling them at home, where there is less expense and trouble in handling the goods, but only a small margin of profit for the manufacturer, which causes the overcrowding of the stores at home and a reduction of prices for lack of demand.

The time will come when manufacturers will see this more clearly, and efforts will be made to reach the vast army of consumers direct. The European thoroughly understands this, and consequently the bulk of trade is in his hands. England, France, and Germany virtually control the entire South American market.

Another reason why the manufacturer is slow in opening up this business is the difficulty in making up the assortments for this market. The American manufacturer assumes that this market demands that the quantities of a certain article are to be smaller and the variety larger; that, for instance, instead of putting up cases or bales of merchandise all of one pattern or design, this trade demands cases or bales assorted in different patterns or designs. All these details could be easily learned, provided the American manufacturer showed a little more of his boasted enterprise and energy. Why not open a foreign department in his factory and adapt it exclusively to the demands of the foreign market, sending representatives to these countries to secure trade? By a judicious expenditure of labor and money, the result can not remain in doubt.

But, in my opinion, the way of attaining the best results would be to open American business houses in the largest distributing centers of South America, which would handle American goods exclusively.

This would be impossible for any establishment to undertake alone, but consolidation of interests might accomplish it without too much individual risk.

The question of personnel is also an important factor. There is no use in sending men here who do not understand Spanish and can not accommodate themselves to the habits and customs of these people, preeminently different from our own. A man must first of all be a gentleman in every sense of the word. Polish goes a great way here. You can not do things in a rush, but persistence and hard work will tell. I have observed that many American drummers sent to these countries to sell goods are, on account of their behavior, a detriment to American business, some of them not knowing what it is to be sober after eight o'clock in the morning, and, after staying a few months at a local hotel, they frequently leave without paying their board. The result is that good men suffer from their behavior. The English or German representatives are totally different, as a rule. The house which sends them here generally furnishes them with letters of credit, and such a thing as not paying for what they get is unknown. They are generally well posted, educated gentlemen, and, comparatively speaking, far superior to the average drummer from our country. The latter do not compare at all favorably with our traveling salesmen at home.

I wish to emphasize the necessity of sending good men to represent American interests, and I know that we have many such, if only care is taken in their selection. If these suggestions were followed, the result would be surprising, for American goods can undoubtedly stand the highest competition and will sell alongside the best of European makes. They are in many cases admittedly superior and fully as cheap. Now is the time for the American manufacturer to introduce his goods into these markets, and, with the application of his usual common sense, he can beat the world in the sale of cotton fabrics and reap the benefits of an immense commerce, which is to-day sadly neglected.

Here are a few articles which, in my opinion, can be sold in this market: Prints, light and dark, ordinary width; prints, light and dark, wider; ginghams, staple, small checks; ginghams, larger checks; cretonnes and chintz, lining cambrics and silesia, bleached and unbleached cottons, cottonades for suitings, denims and tickings, cotton blankets, white and colored cotton bedspreads, checked and striped nainsooks, printed lawns and challies, cotton toweling by the yard, cotton towels by the piece, mosquito netting, and many other similar items.

Packing is a factor to be considered, as, by the customs laws here, everything pays duty according to weight; therefore, everything in excess of what is ab-

solutely necessary, such as cardboard or boards on which goods are folded or rolled, should be omitted. Heavy packing cases pay the full amount of the specified duty on the contents. Another thing to be considered is that packages must only contain merchandise of one particular kind, since if there are many kinds, the whole must pay duty as of the higher class, of which there may only be a small quantity.

LOUIS GOLDSCHMIDT, Consul.

La Guayra, November 25.

WHAT SCIENCE IS DOING FOR THE WORLD.

IT certainly seems at first sight to be an economic danger, this educating of the laboring man and woman to be far too good for laborer's work. Let us cast our thoughts, however, over a wider horizon, and see how the decades that bring the peril are also bringing the remedy. Science is steadily sweeping away all those humblest classes of employment. Hardly any man has now to toil up ladders with the hod of bricks upon his shoulder. The donkey-engine does the purely animal part of the work. The reaper is replaced by the machine, and the plowman is fast receding as the steam plow makes its appearance. We rarely see long lines of men, laden with coal bags, running up planks as in the olden days. The need of men to do the work of horses is steadily diminishing.

It is true that science has by no means conquered the whole domain. There is still much scrubbing of floors to be done by men and women on bended knees; and coal is still hewn out with pick and ax and the use of muscle, with but little use of brain. And yet, even in our fertile century, science never works by revolution, but only by progress. One domain after another has gone. Where are now the armies of water carriers, and chair porters, and night men and sawyers whom our grandfathers used to require? Imagine, if ships had still to be moved by galley rowers, what millions would be doomed to a beast-like toil. Some parts of the big domain of unreflective labor will long be left untouched, but the process is going forward; and it is clear that while education is rendering the lower classes unfit for the humblest sorts of occupations, science is steadily sweeping away these occupations. It would be too much to hope that these processes should be at all times strictly proportioned to one another, but in the general drift of things they are compensatory, and if we only give to science a reasonable time it will leave us none of that labor to be done which requires an uneducated laborer.

Then comes the uneasy question as to what is to become of the classes thus deprived of occupation. The working classes themselves often curse the progress of invention, and are tempted to look upon it as no friend to their welfare. There are now, it is true, no longer any machine-breaking frenzies; but the difficulty often arises in an acute, though silent, suffering. Unfortunately, society has always to travel to permanent good through transitory ills. When an army of compositors is dismissed because some one has invented a linotype machine, there is excuse for some bitterness of feeling. And yet there was a time when a whole army of manuscript book-copiers had to give way before the advent of the compositor.

But the difficulty is always evanescent, for here, too, there are compensating influences at work. For if science is abolishing occupations at the lower end of the scale, she is creating new ones at the top. Think of the hundreds of thousands of men who in England are now employed in callings that had no existence sixty years ago: the telegraphers, and photographers, and mechanists of a hundred kinds. In the last decade or two what an army of skilled men have been demanded by the inventions of the bicycle, the telephone, and the electric light! As compared with the beginning of the century, think of the long array of marine and locomotive engineers, the chemists, the journalists, the draughtsmen, the teachers, the postmen, railway porters, and tram conductors. What a multitude of callings are there which are either new, or else newly stocked, so that while the population has quadrupled their ranks have been multiplied a hundredfold. But it is the entirely new employments that strike the mind most forcibly, and any one who runs his eye down a census of the occupations of the people will satisfy himself that in England of the present day one-fifth part of the adult male population find their livelihood in callings that had no existence when the century began.

Thus while science takes away with one hand it liberally bestows with the other; but what it takes away are the low-class occupations, and what it gives are the high-class ones, demanding intelligence and cultivating it. The general tendency is therefore humanizing.

But of course it never happens that the coal heaver, when thrown out of work by the introduction of a steam crane, can go away and get a place in one of the newly created superior callings. He is not such a fool as to waste his time in applying for an opening as an electrical engineer. But there is a gradual creeping up that is always taking place. And yet the transfer is much less effected by the promotion of individuals than by promotion of generations. No doubt it sometimes happens that the intelligent plumber steps into the new opening for an electrical engineer, and leaves a gap which some one of an inferior calling steps into; the gaps being filled in succession, until, perhaps, the riveter, thrown out of work by the introduction of hydraulic machinery, finds a vacancy at last and steps into it. But it more frequently happens that the plumber educates his son to be an electrical engineer, and the carter apprentices his boy to the plumber, and the dock laborer sees his young folk aspiring to be carters.

Thus the general drift of the whole social scale is steadily upward in proportion as science provides intelligent occupations at the upper end and abolishes those that are more or less brute-like at the lower, and so humanity as a whole is the gainer. There is therefore no reason to feel uneasy at a prospect of over-education.—The Nineteenth Century.

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PAGE

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